US009175898B2

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Chae et al.

(10) **Patent No.: US 9,175,898 B2**
(45) **Date of Patent: Nov. 3, 2015**

(54) **REFRIGERATOR HAVING COLD AIR GENERATING COMPARTMENT AND MACHINE ROOM POSITIONED AT UPPER PORTION OF CABINET**

(75) Inventors: **Su Nam Chae**, Seoul (KR); **Kyeong Yun Kim**, Seoul (KR); **Jang Seok Lee**, Seoul (KR); **Min Kyu Oh**, Seoul (KR); **Youn Seok Lee**, Seoul (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

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(22) Filed: **Dec. 9, 2009**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jan. 30, 2009 (KR) 10-2009-0007298

(51) **Int. Cl.**

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F25D 17/06	(2006.01)
F25D 17/08	(2006.01)
F25D 19/00	(2006.01)
F25D 17/04	(2006.01)
F25D 21/14	(2006.01)

(52) **U.S. Cl.**

CPC ***F25D 17/065*** (2013.01); ***F25D 17/08*** (2013.01); ***F25D 19/00*** (2013.01); *F25D 17/045* (2013.01); *F25D 21/14* (2013.01); *F25D 2317/0651* (2013.01); *F25D 2317/0654* (2013.01); *F25D 2317/0665* (2013.01); *F25D 2317/0682* (2013.01); *F25D 2400/06* (2013.01)

(58) **Field of Classification Search**

CPC F25D 17/08; F25D 17/065; F25D 17/045; F25D 19/00; F25D 21/14; F25D 2317/0651; F25D 2317/0654; F25D 2317/0665; F25D 2317/0682; F25D 2400/06

USPC 62/177, 178, 186, 187, 216, 217, 419

See application file for complete search history.

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Primary Examiner — Ljiljana Ciric

(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

A refrigerator includes a cabinet comprising a storage compartment An evaporator is positioned at an upper portion of the cabinet and generates cold air supplied to the storage compartment. A unit (e.g., closable damper) controls supply of cold air generated by the evaporator to the storage compartment.

13 Claims, 21 Drawing Sheets

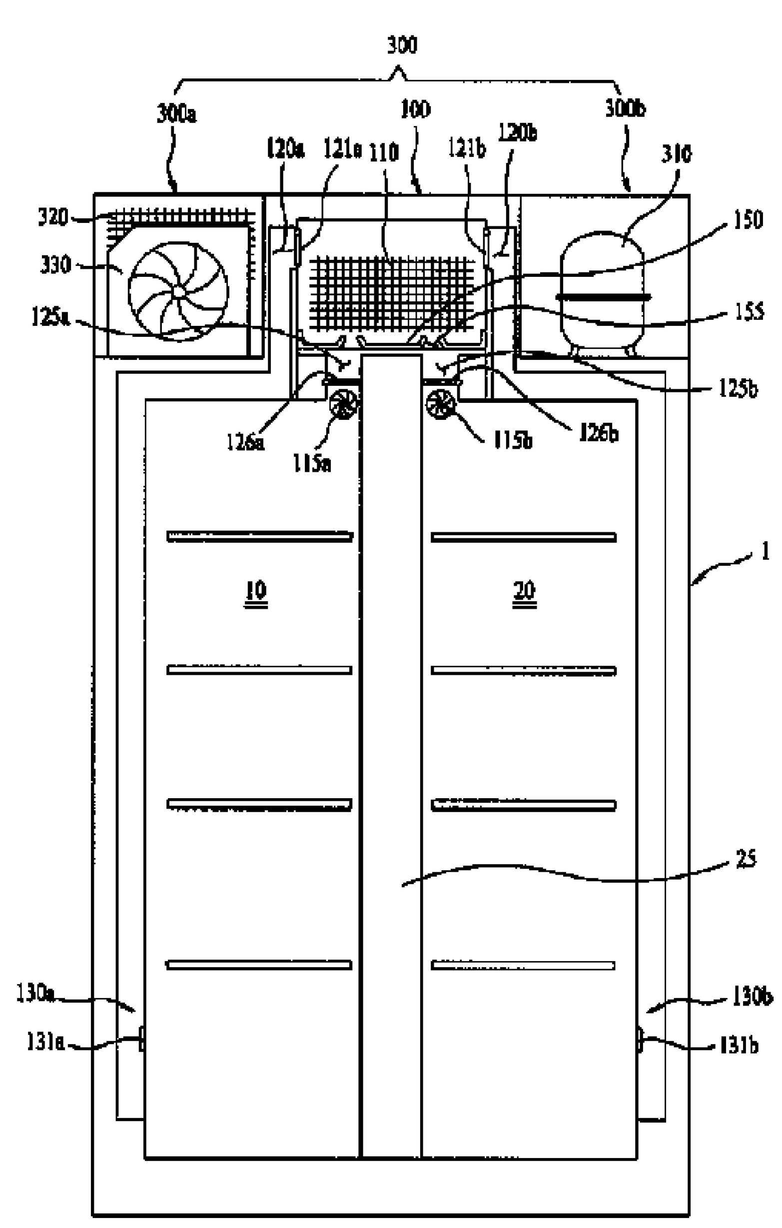

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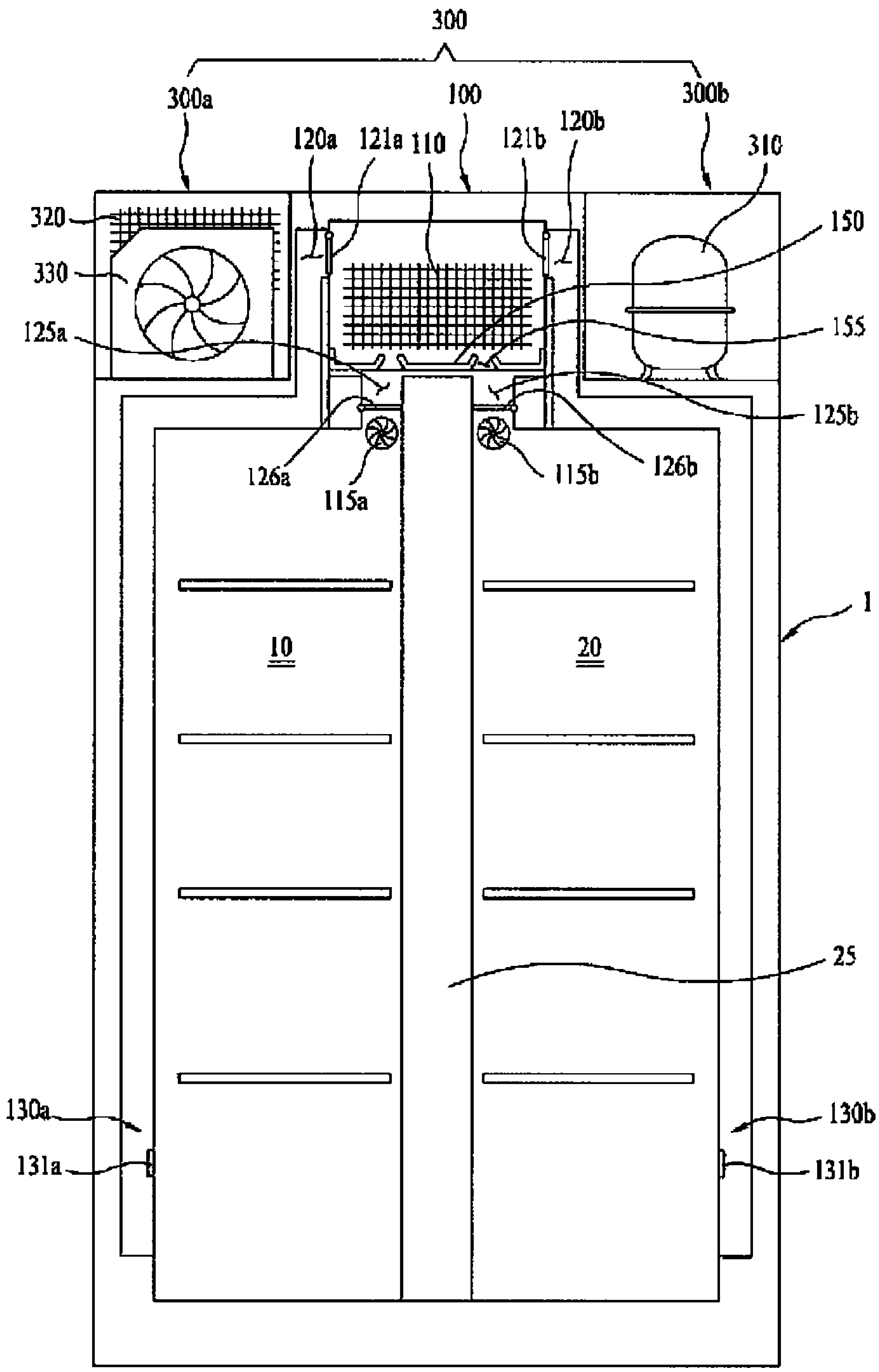
FIG. 1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120b
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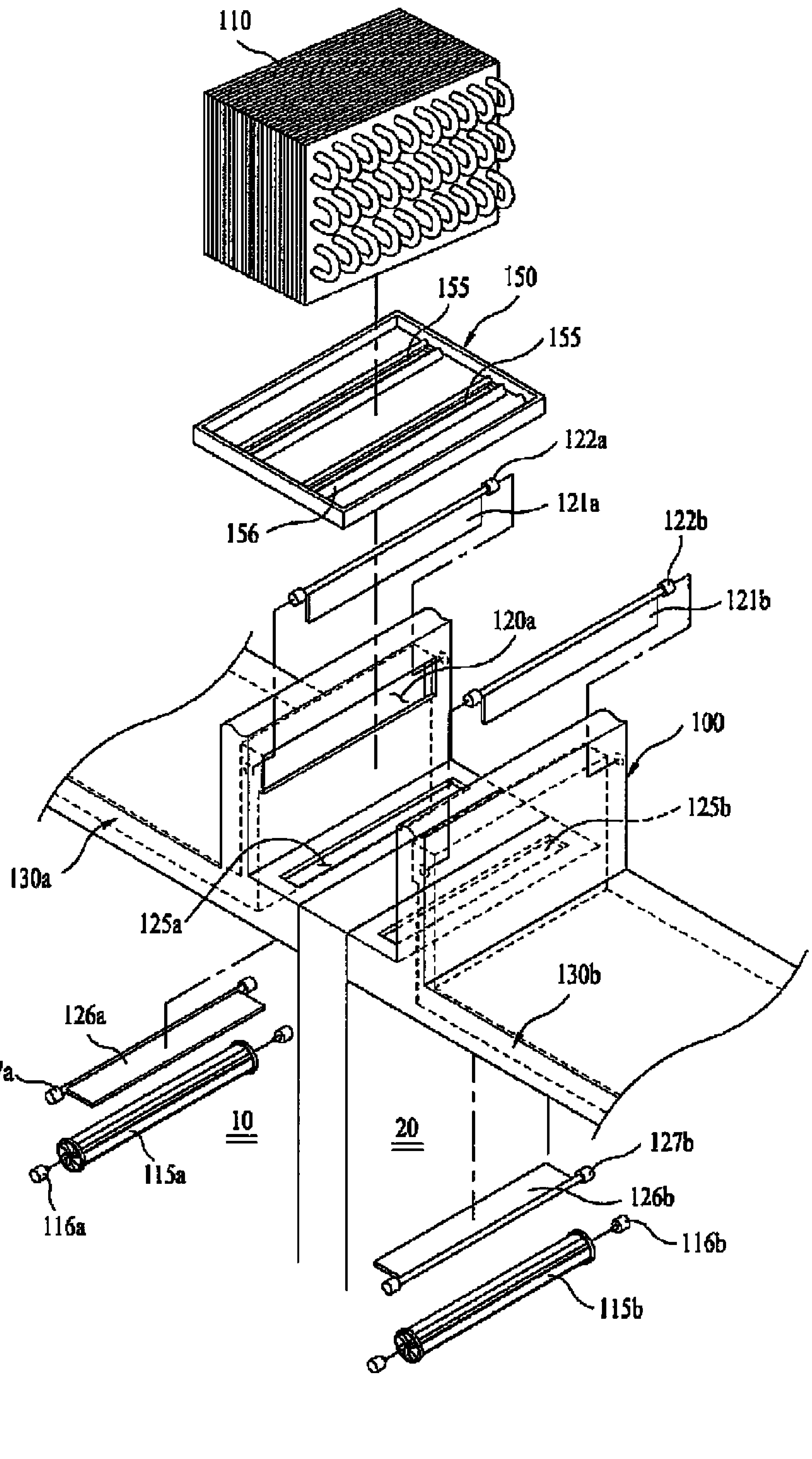
115a
115b
126b
1
10
20
25
130a
131a
130b
131b

FIG. 2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155
150
155
122a
121a
156
122b
121b
120a
100
125b
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125a
130b
126a
127a
10
20
115a
116a
127b
126b
116b
115b

FIG. 3

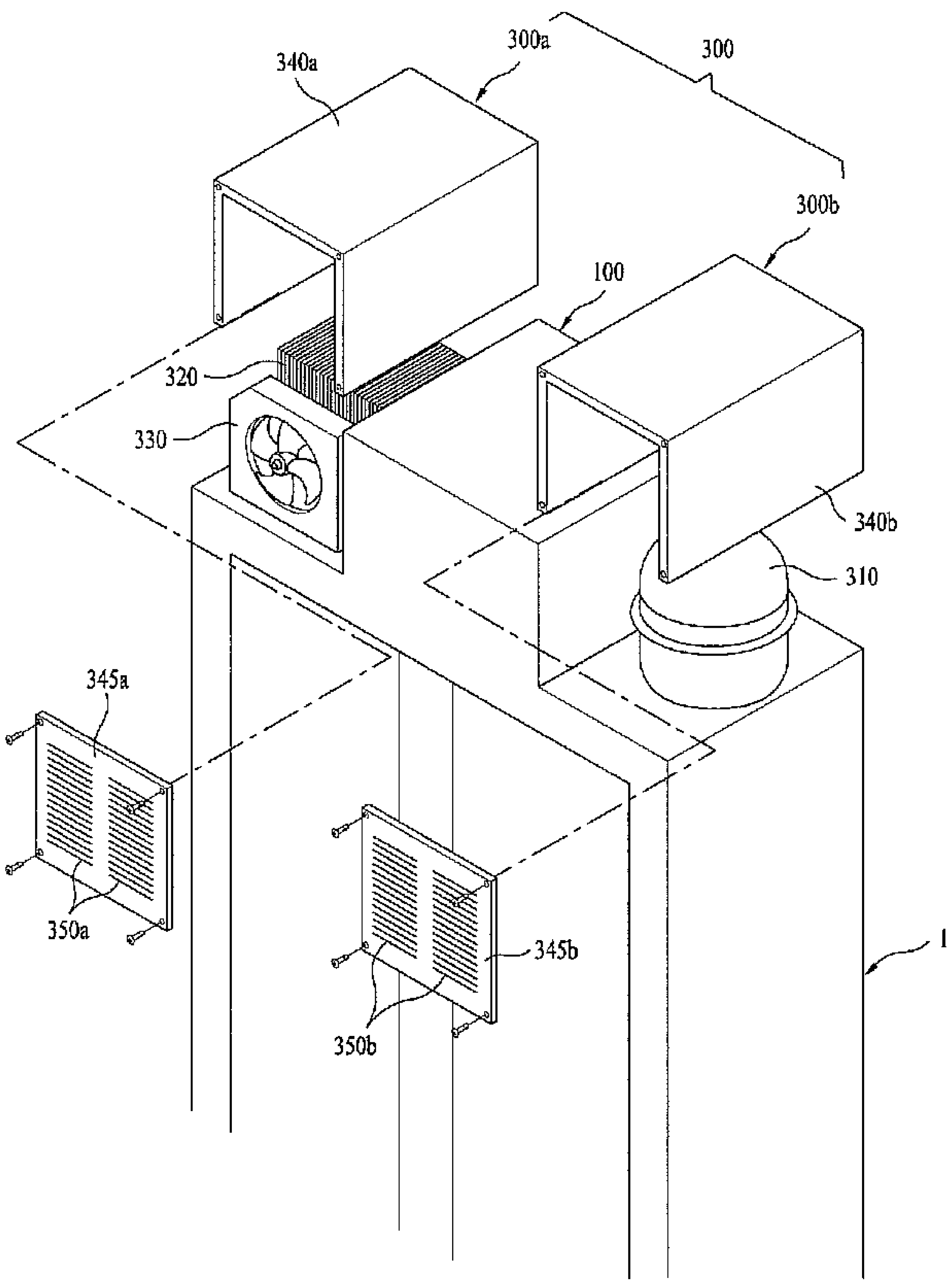


FIG. 4

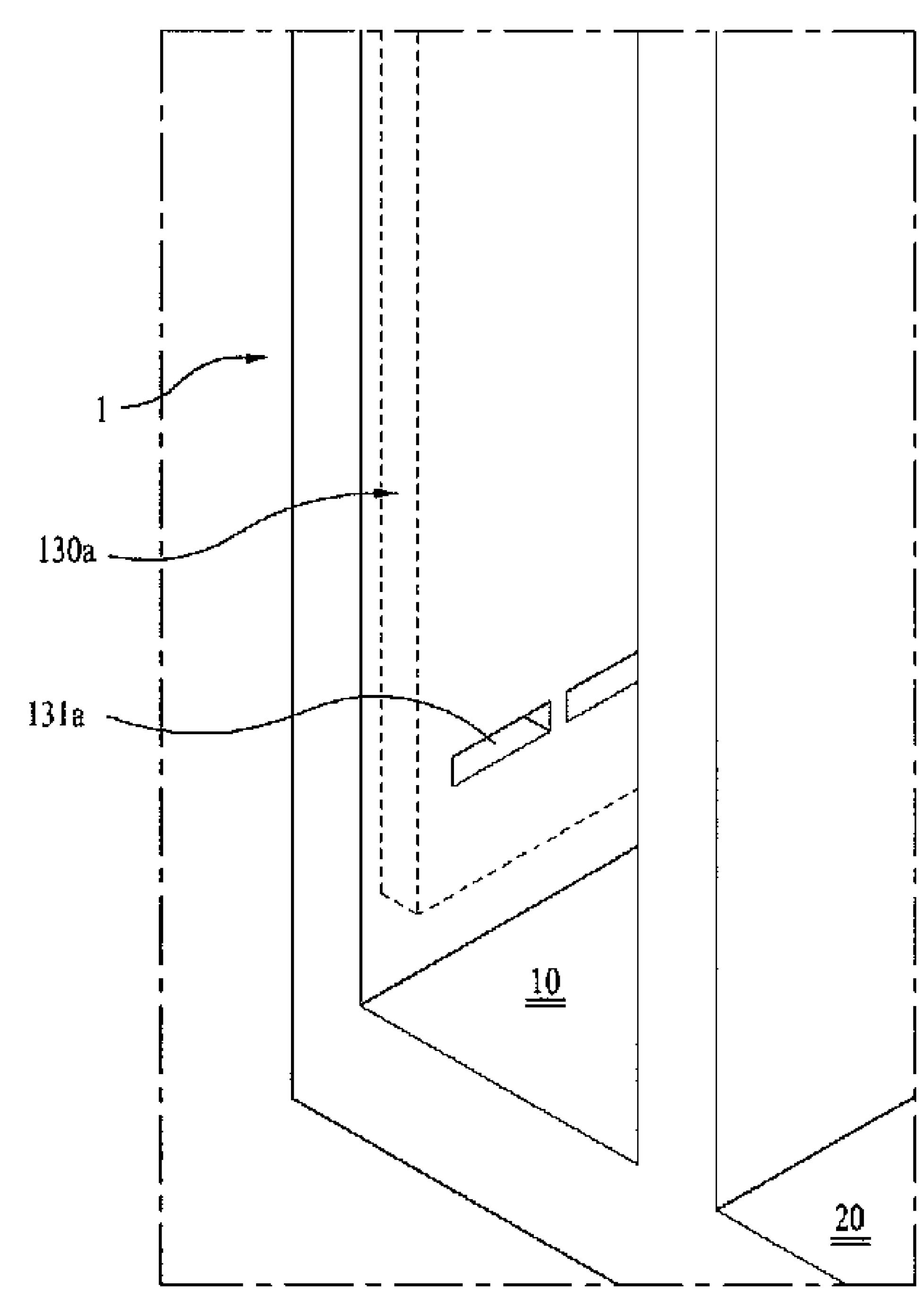
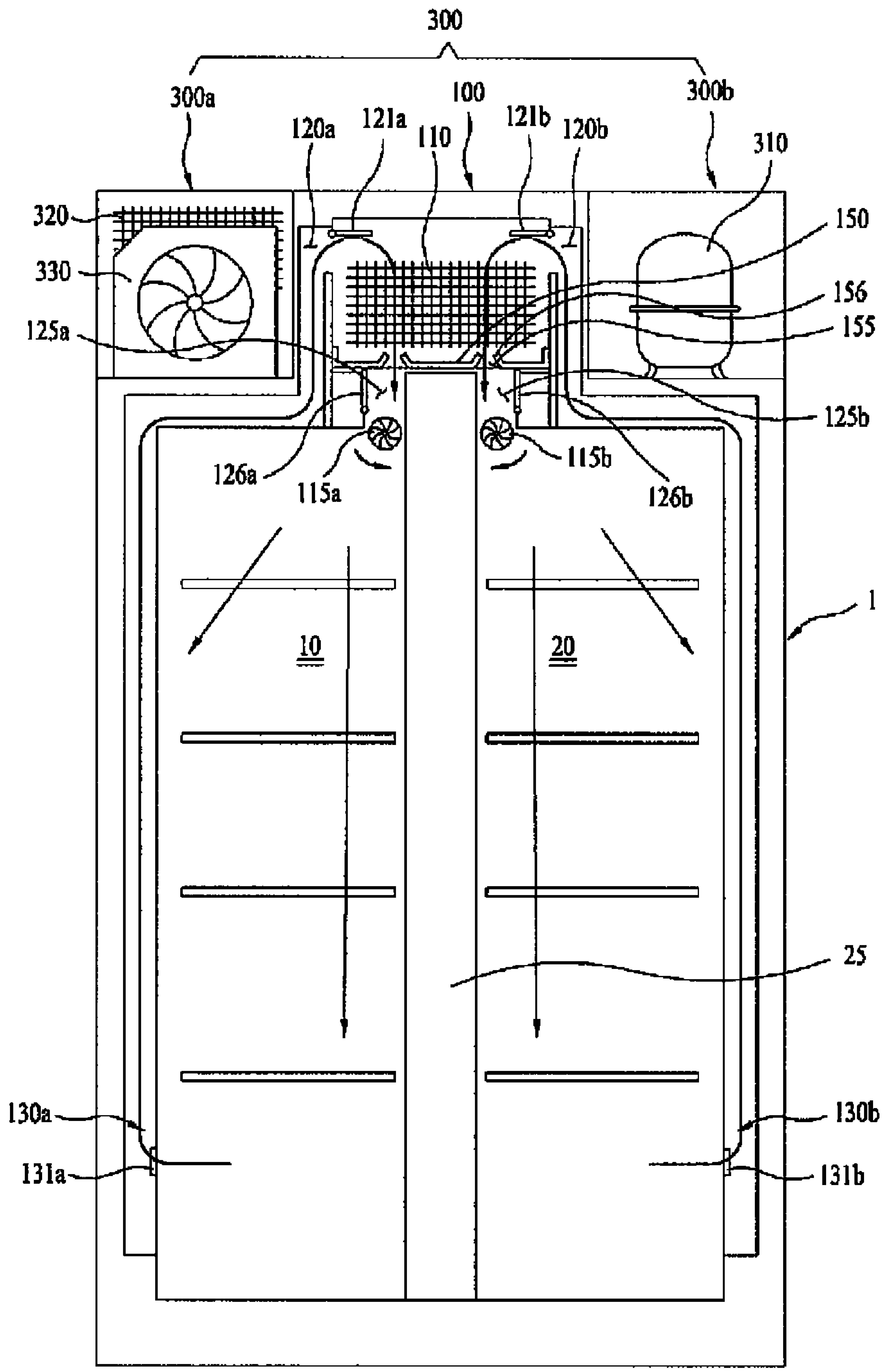


FIG. 5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300b
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121a
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120b
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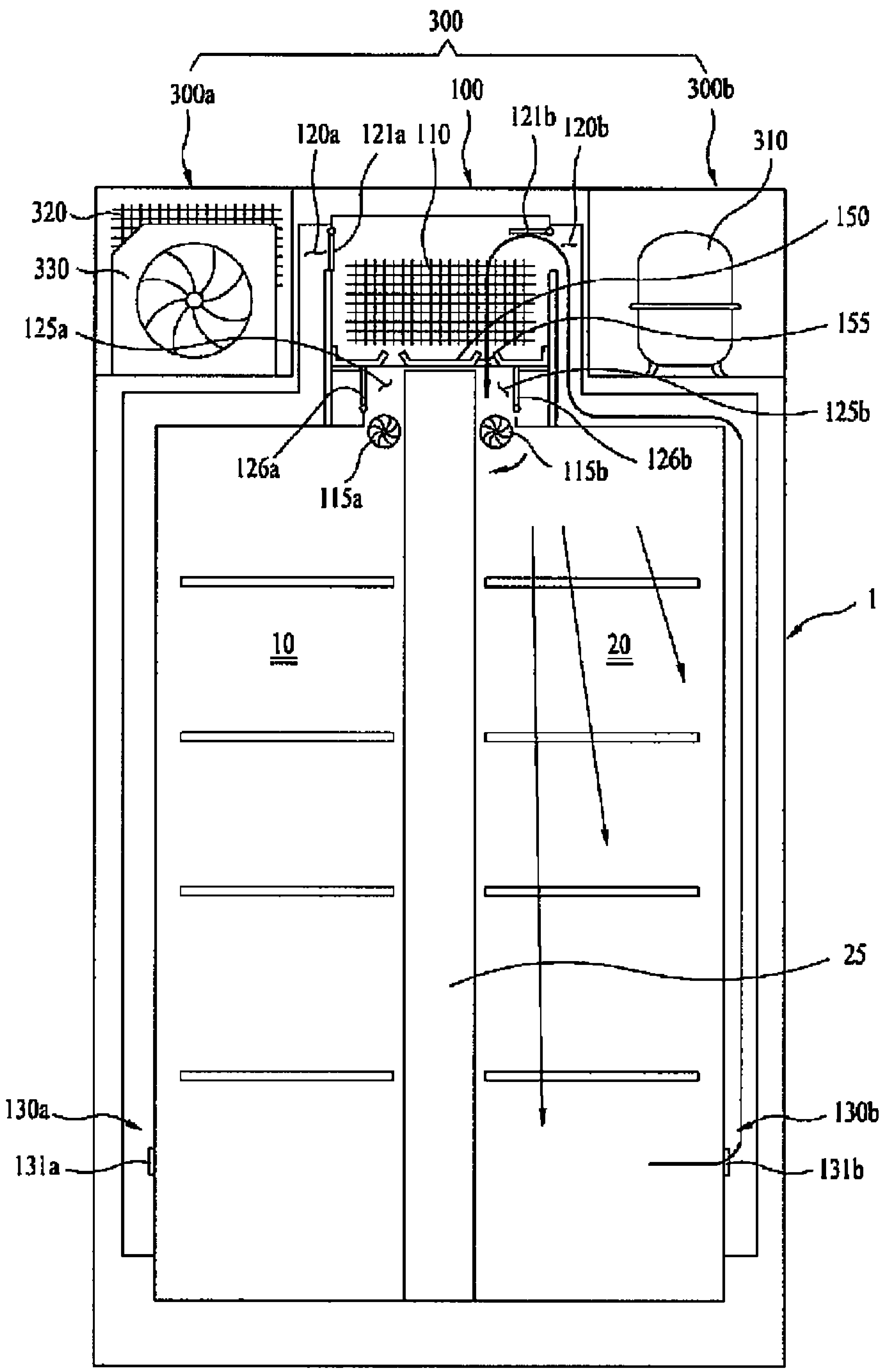
125b
126a
115a
115b
126b
1
10
20
25
130a
130b
131a
131b

FIG. 6



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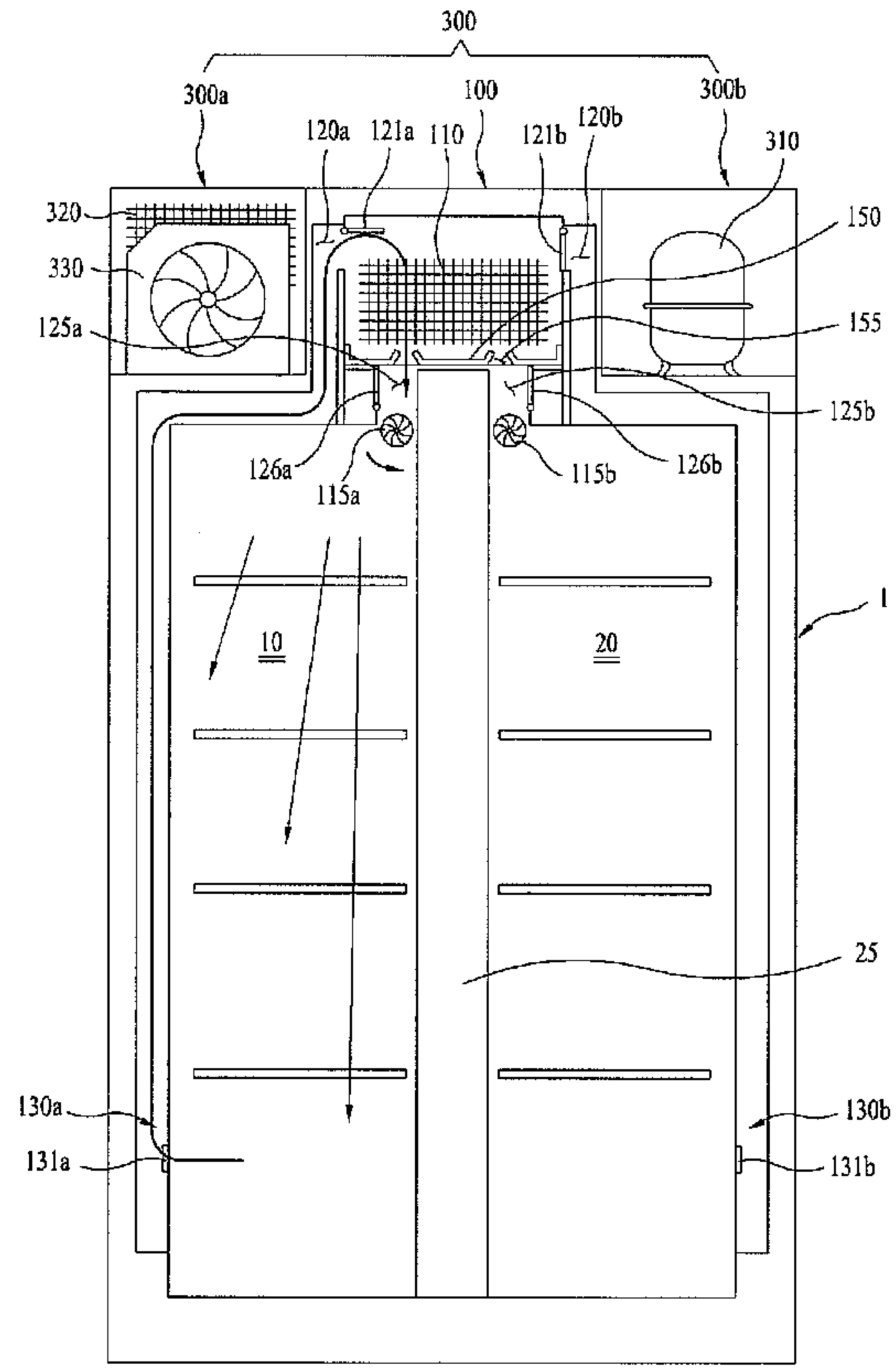
300b
120a
121a
110
121b
120b
310
320
330
150
125a
155
125b
126a
115a
115b
126b
10
20
1
25
130a
131a
130b
131b

FIG. 7



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300a
100
300b
120a
121a
110
121b
120b
310
320
150
330
125a
155
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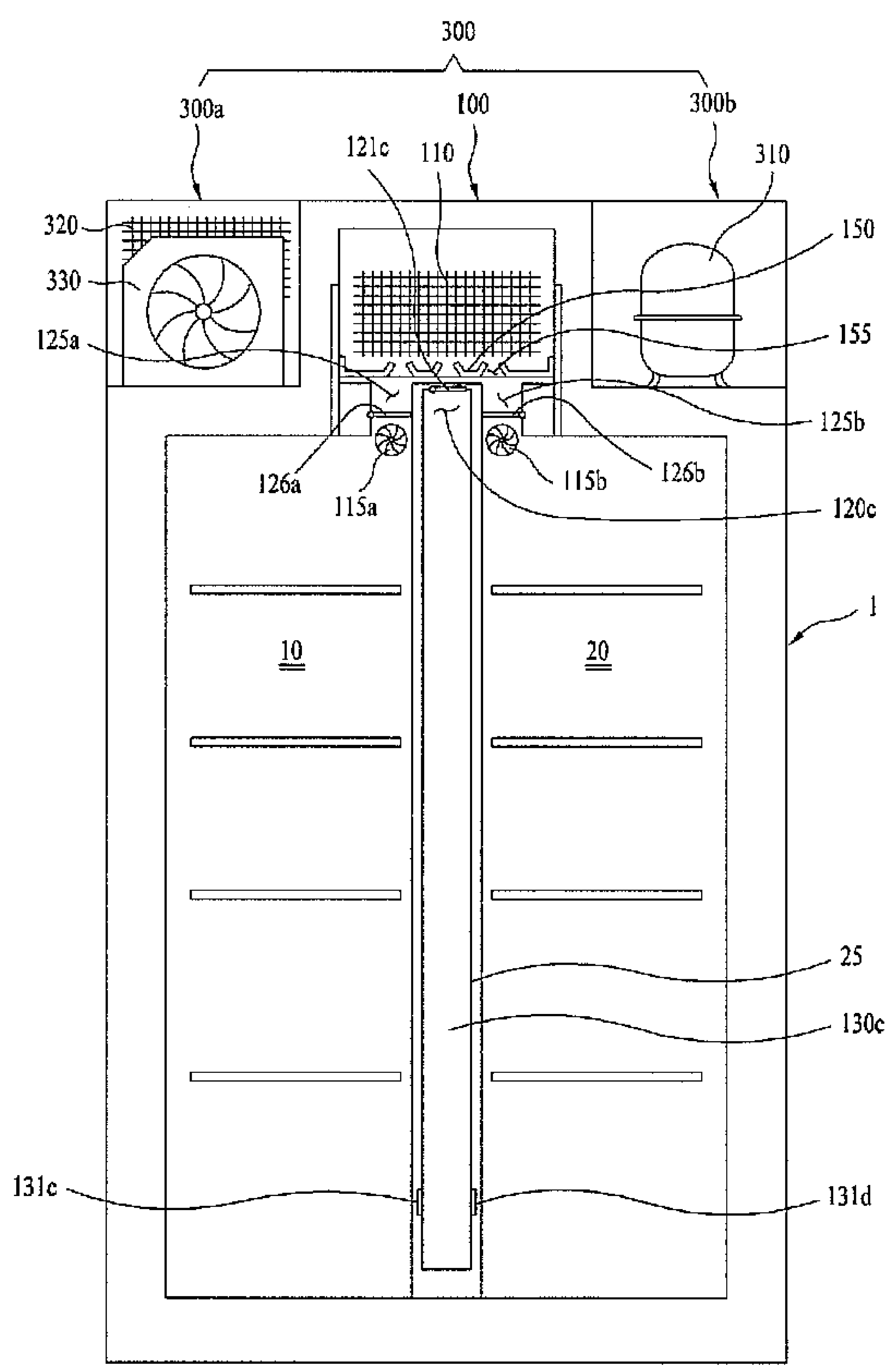
126a
115a
115b
126b
1
10
20
25
130a
131a
130b
131b

FIG. 8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300a
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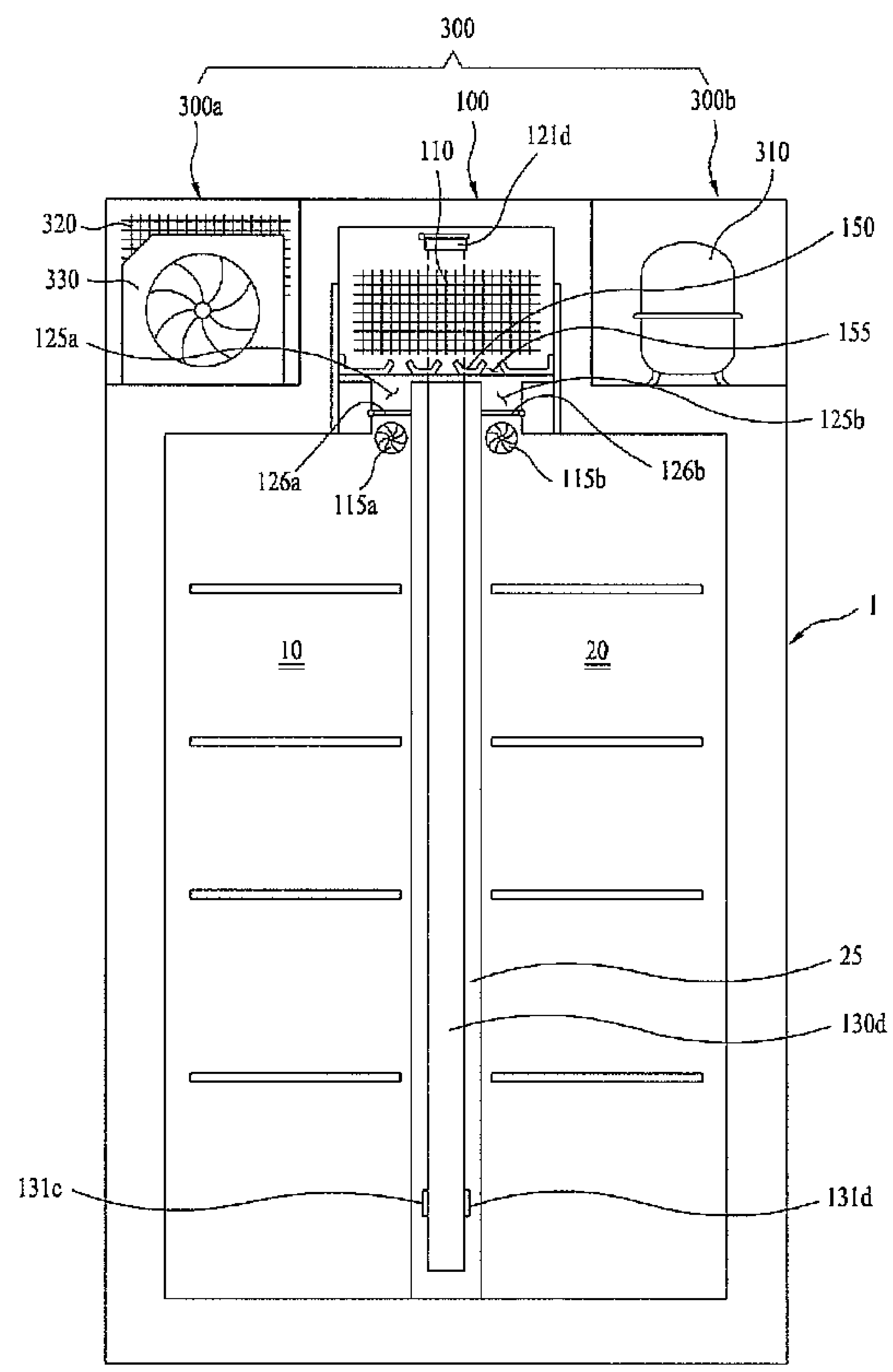
300b
121c
110
310
320
150
330
155
125a
125b
126a
115a
115b
126b
120c
1
10
20
25
130c
131c
131d

FIG. 9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300a
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300b
110
121d
310
320
150
330
155
125a
125b
126a
115a
115b
126b
1
10
20
25
130d
131c
131d

FIG. 10

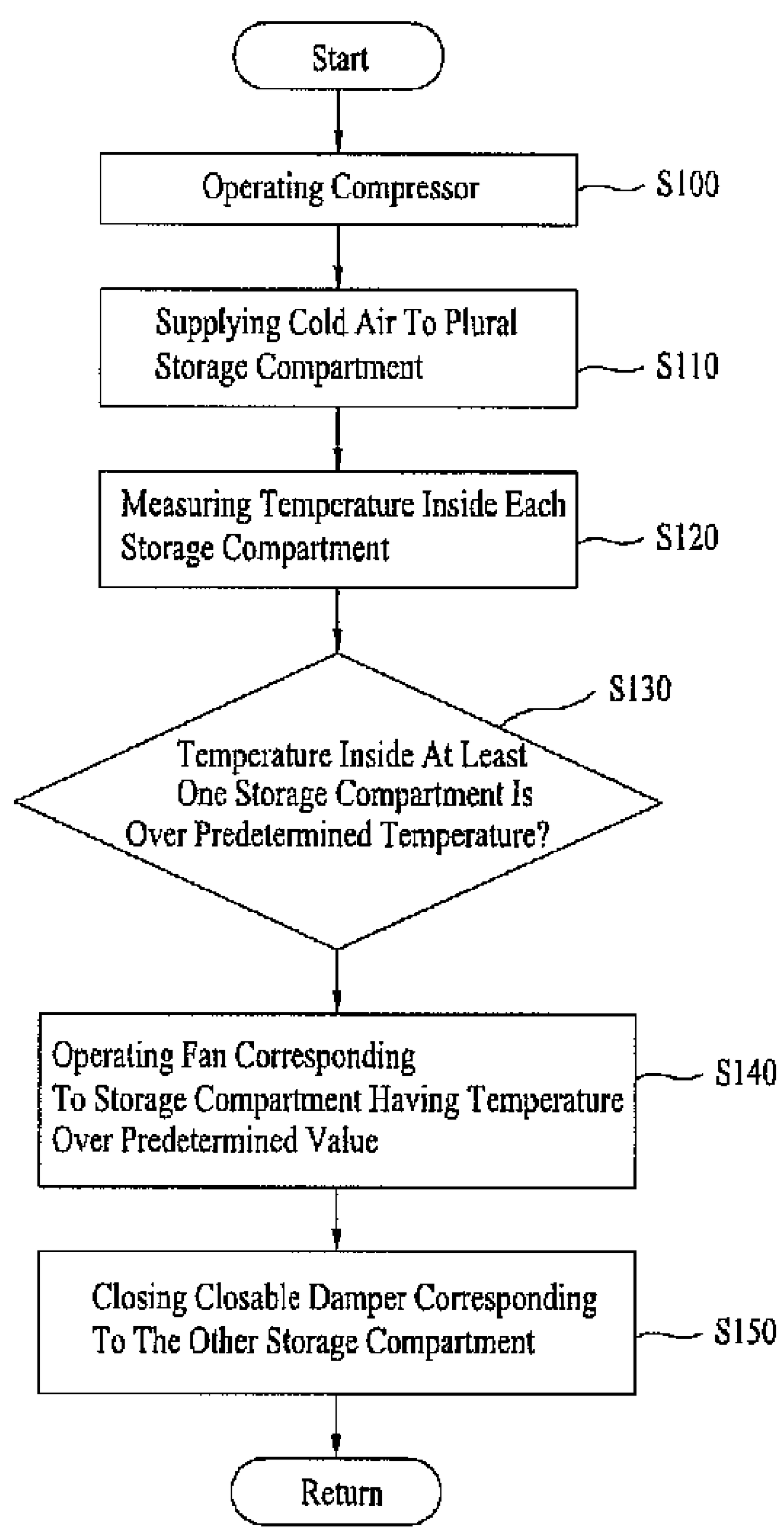

Start
Operating Compressor
S100
Supplying Cold Air To Plural Storage Compartment
S110
Measuring Temperature Inside Each Storage Compartment
S120
S130
Temperature Inside At Least One Storage Compartment Is Over Predetermined Temperature?
Operating Fan Corresponding To Storage Compartment Having Temperature Over Predetermined Value
S140
Closing Closable Damper Corresponding To The Other Storage Compartment
S150
Return

FIG. 11

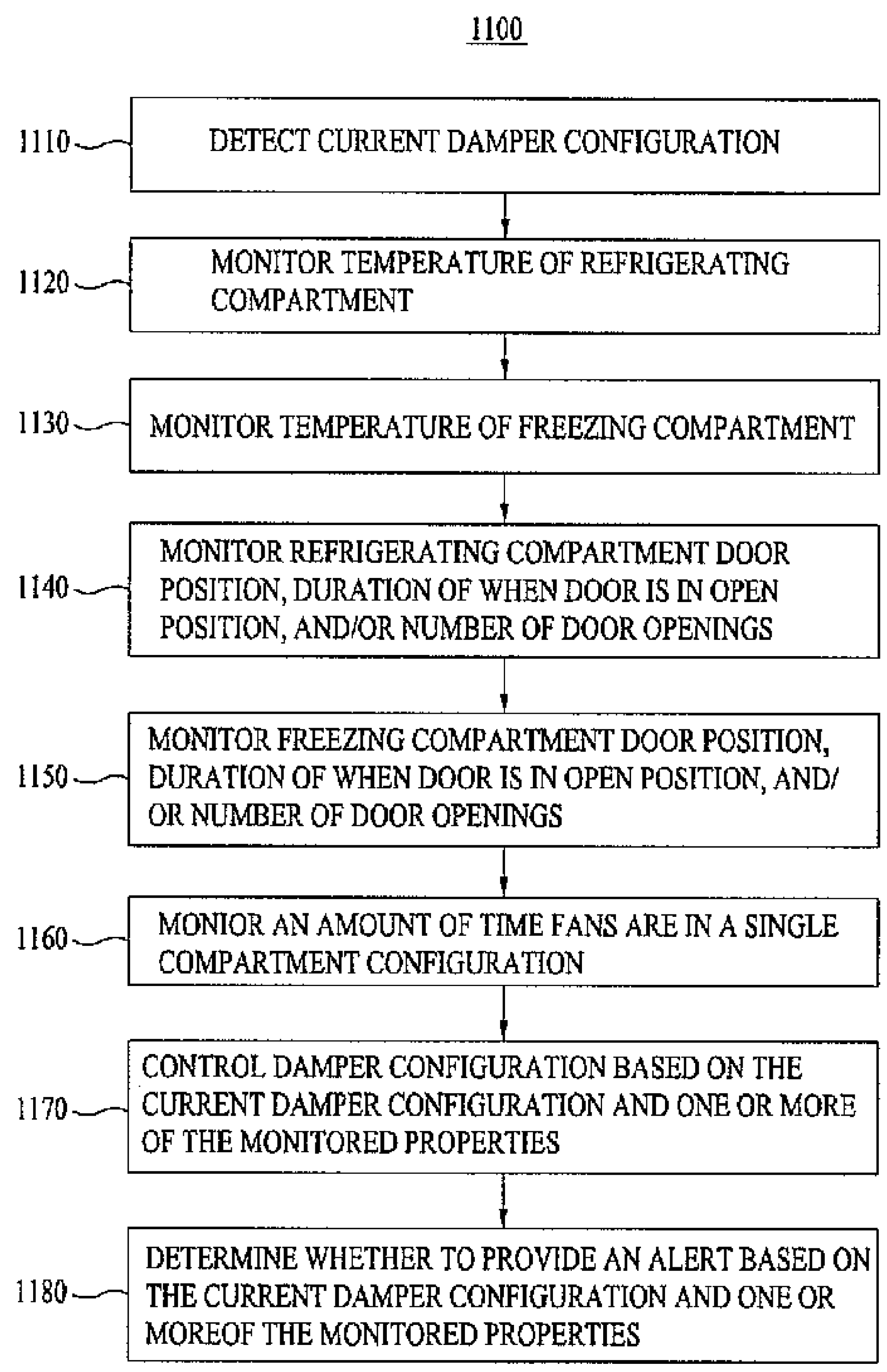

1100
1110 DETECT CURRENT DAMPER CONFIGURATION
1120 MONITOR TEMPERATURE OF REFRIGERATING COMPARTMENT
1130 MONITOR TEMPERATURE OF FREEZING COMPARTMENT
1140 MONITOR REFRIGERATING COMPARTMENT DOOR POSITION, DURATION OF WHEN DOOR IS IN OPEN POSITION, AND/OR NUMBER OF DOOR OPENINGS
1150 MONITOR FREEZING COMPARTMENT DOOR POSITION, DURATION OF WHEN DOOR IS IN OPEN POSITION, AND/ OR NUMBER OF DOOR OPENINGS
1160 MONIOR AN AMOUNT OF TIME FANS ARE IN A SINGLE COMPARTMENT CONFIGURATION
1170 CONTROL DAMPER CONFIGURATION BASED ON THE CURRENT DAMPER CONFIGURATION AND ONE OR MORE OF THE MONITORED PROPERTIES
1180 DETERMINE WHETHER TO PROVIDE AN ALERT BASED ON THE CURRENT DAMPER CONFIGURATION AND ONE OR MOREOF THE MONITORED PROPERTIES

FIG. 12

1200

1210 Current Damper Configuration		1220 Temperature		1230 Door Position		1240 Door Open Duration		1250 Number of Door Openings		1260 Time In Single	1270 Set Damper Configuration	
Freezer	Fridge	Freezer	Fridge	Freezer	Fridge	Freezer	Fridge	Freezer	Fridge	Config.	Freezer	Fridge
Open	Open	In Range	In Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Open	Open
Open	Open	< Range	In Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Closed	Open
Open	Open	In Range	< Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Open	Closed
Open	Open	> Range	In Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Open	Closed
Open	Open	In Range	> Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Closed	Open
Open	Open	> Range	> Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Open	Open
Open	Open	< Range	< Range	Closed	Closed	N/A	N/A	N/A	N/A	N/A	Closed	Closed
Open	Open	> Range	In Range	Open	Closed	< Limit	N/A	< Limit	N/A	< Limit	Open	Closed
Open	Closed	> Range	In Range	Open	Closed	> Limit	N/A	< Limit	N/A	< Limit	Closed	Open
Open	Closed	> Range	In Range	Open	Closed	< Limit	N/A	> Limit	N/A	< Limit	Closed	Open
Open	Closed	> Range	In Range	Closed	Closed	N/A	N/A	N/A	N/A	> Limit	Open	Open
Closed	Open	In Range	> Range	Closed	Open	N/A	> Limit	N/A	> Limit	< Limit	Open	Closed
Closed	Open	< Range	> Range	Closed	Open	N/A	> Limit	N/A	> Limit	< Limit	Closed	Closed
Open	Open	In Range	In Range	Closed	Open	N/A	> Limit	N/A	< Limit	N/A	Open	Closed
Open	Open	> Range	> Range	Open	Open	< Limit	> Limit	< Limit	< Limit	N/A	Open	Closed

FIG. 13

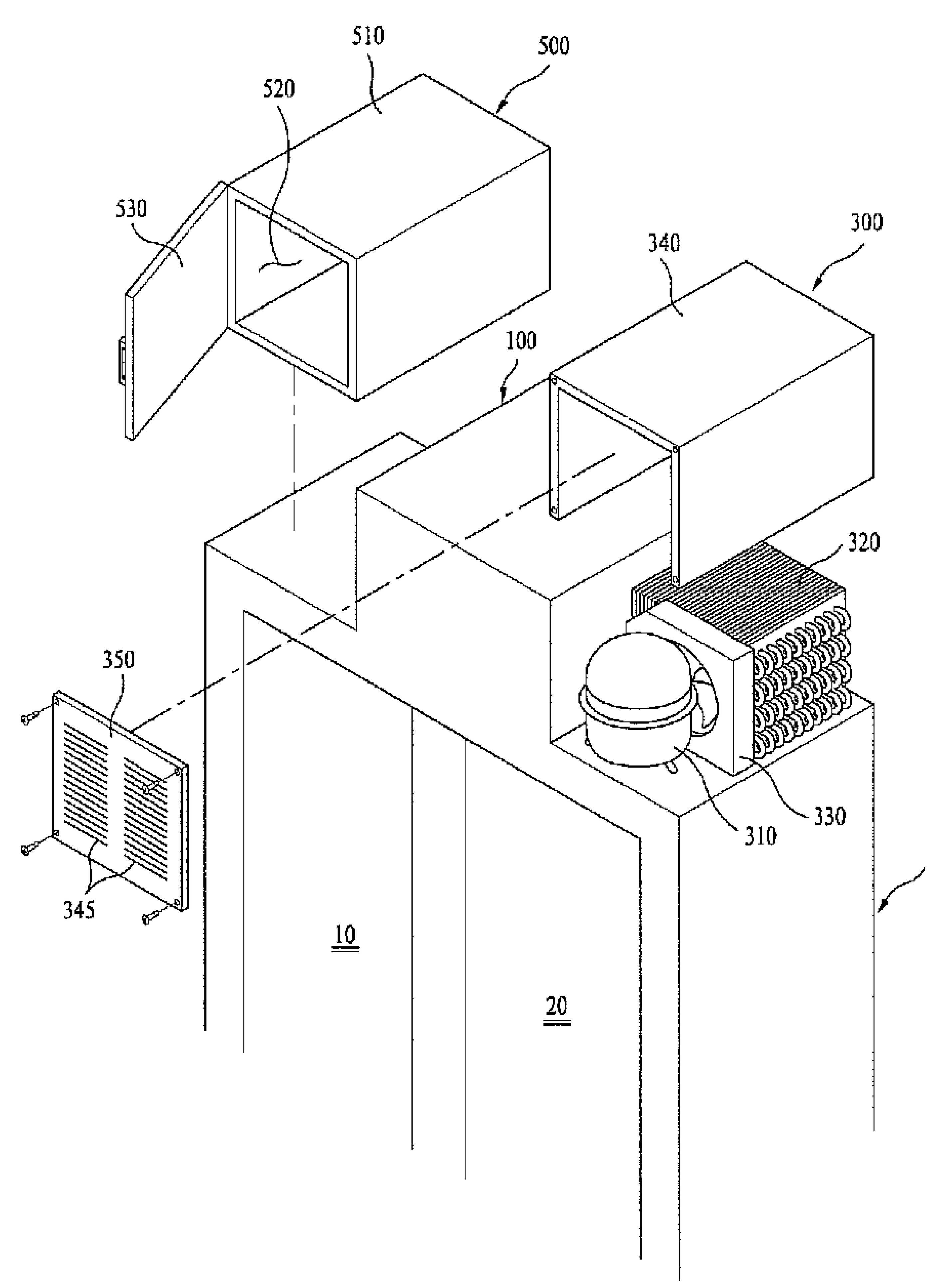


FIG. 14

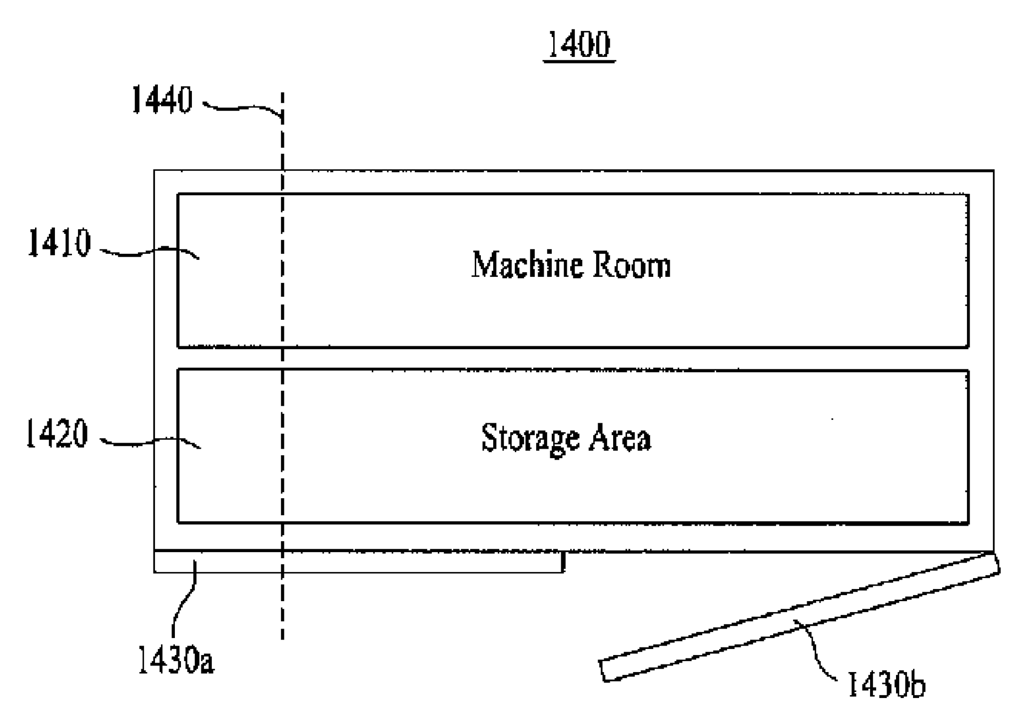


FIG. 15

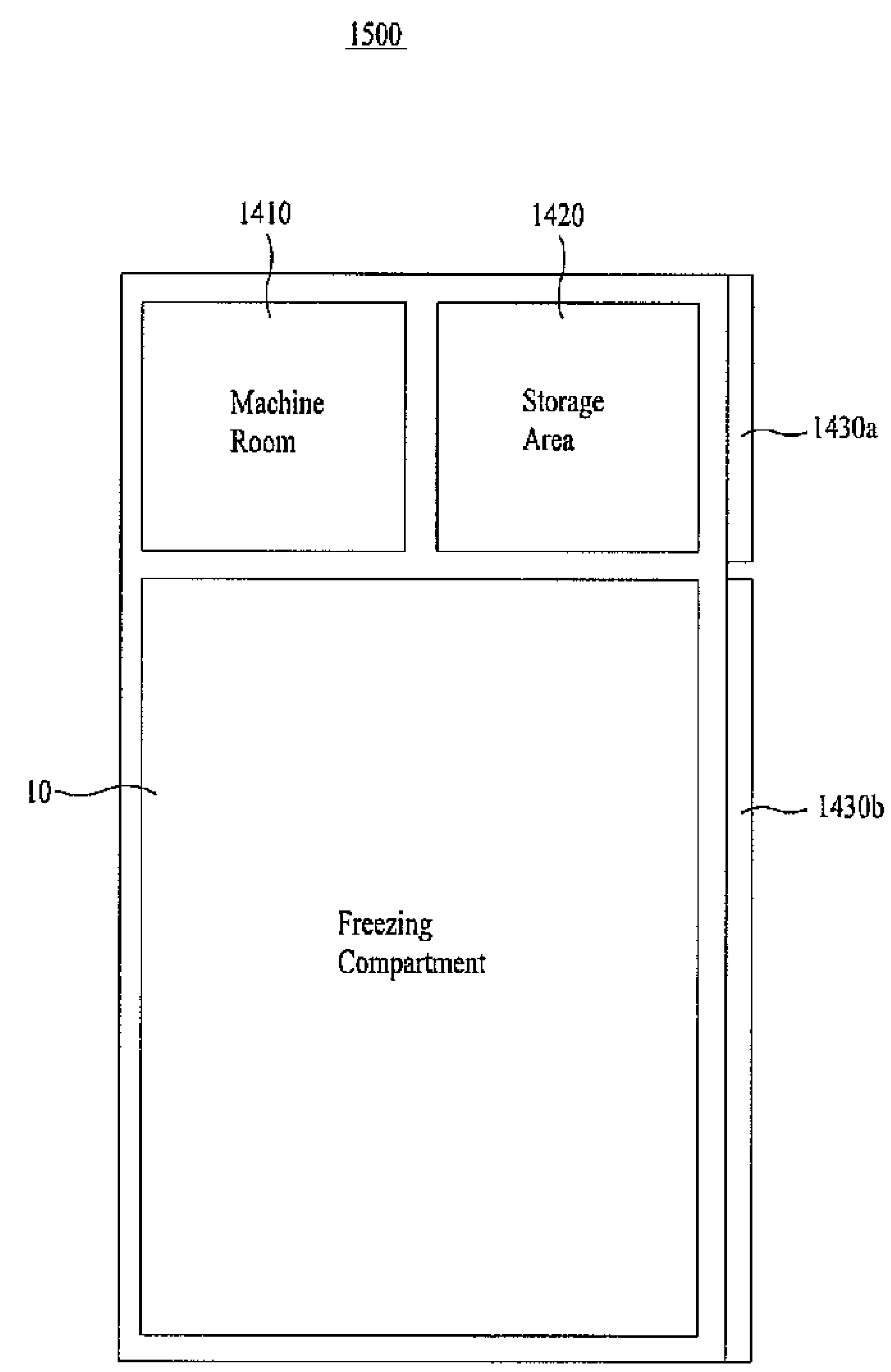

1500
1410
1420
Machine
Room
Storage
Area
1430a
10
1430b
Freezing
Compartment

FIG. 16

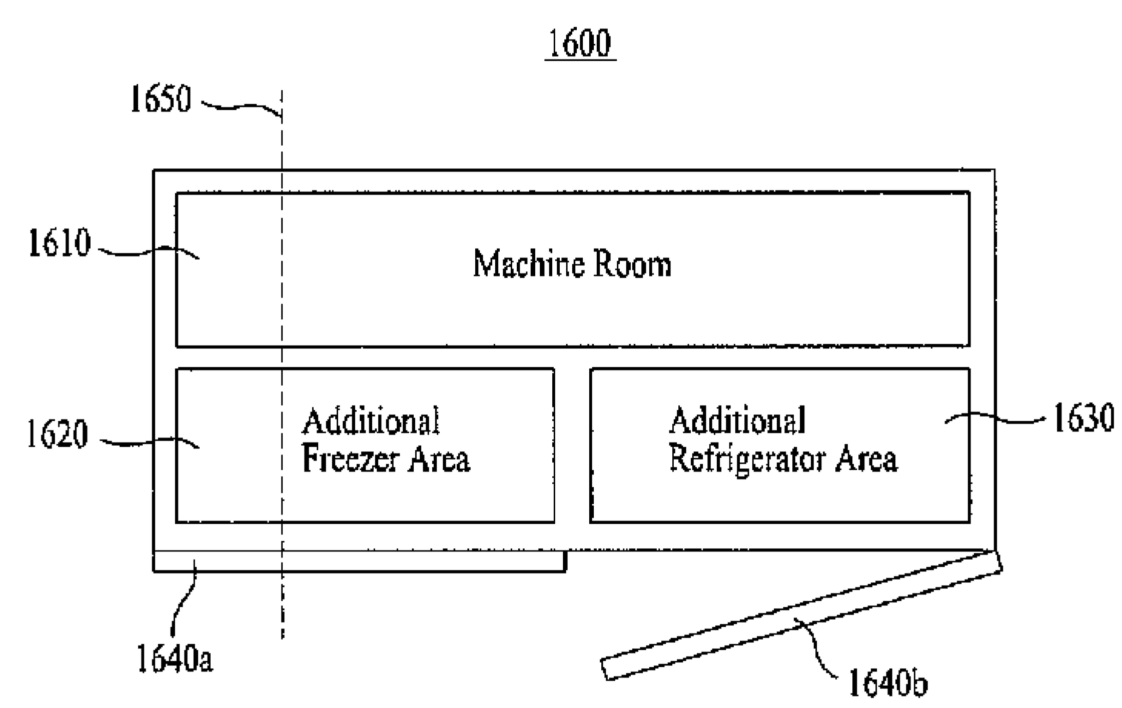

1600
1650
1610
Machine Room
1620
Additional
Freezer Area
Additional
Refrigerator Area
1630
1640a
1640b

FIG. 17

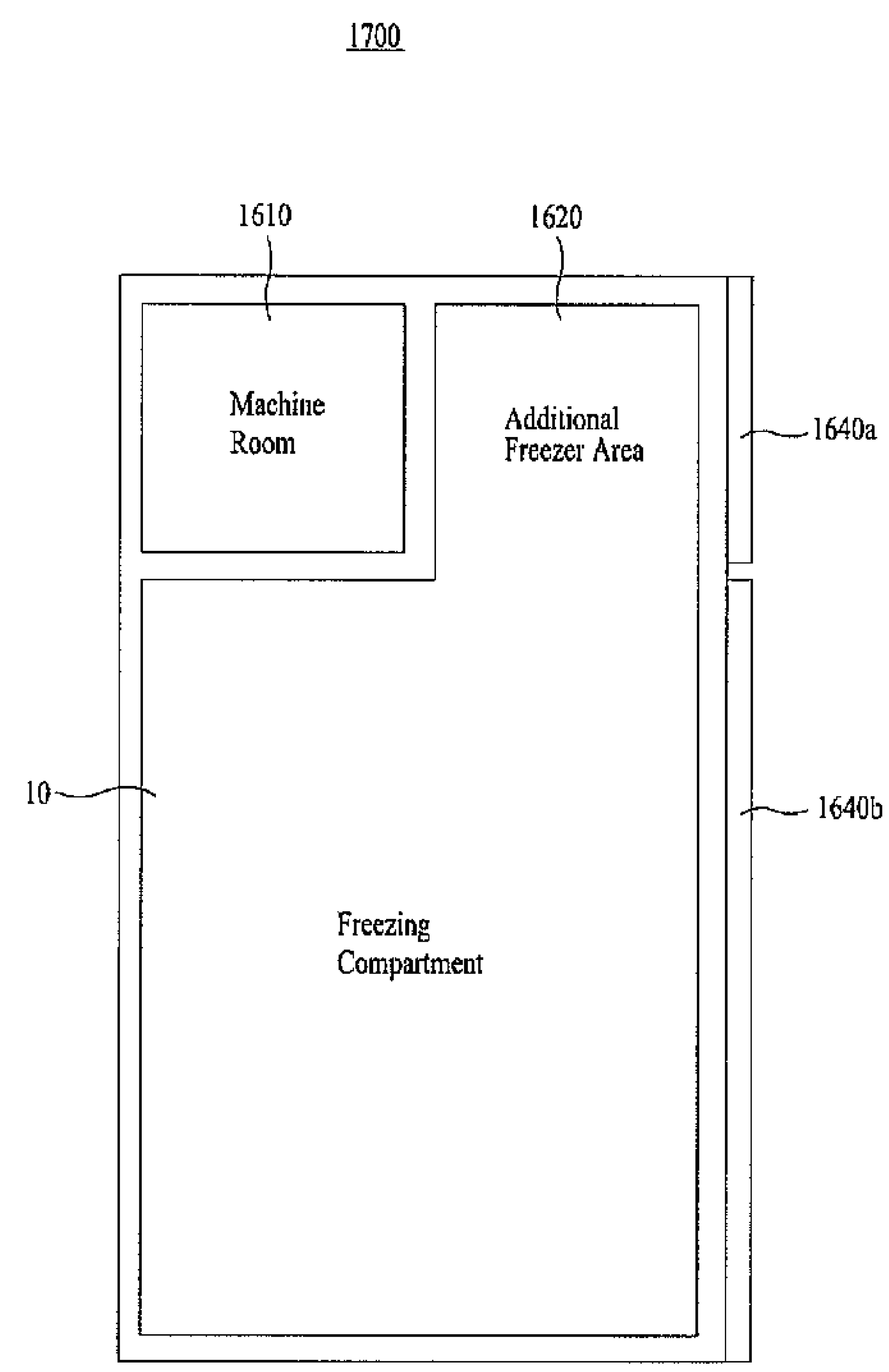

1700
1610
1620
Machine Room
Additional Freezer Area
1640a
10
1640b
Freezing Compartment

FIG. 18

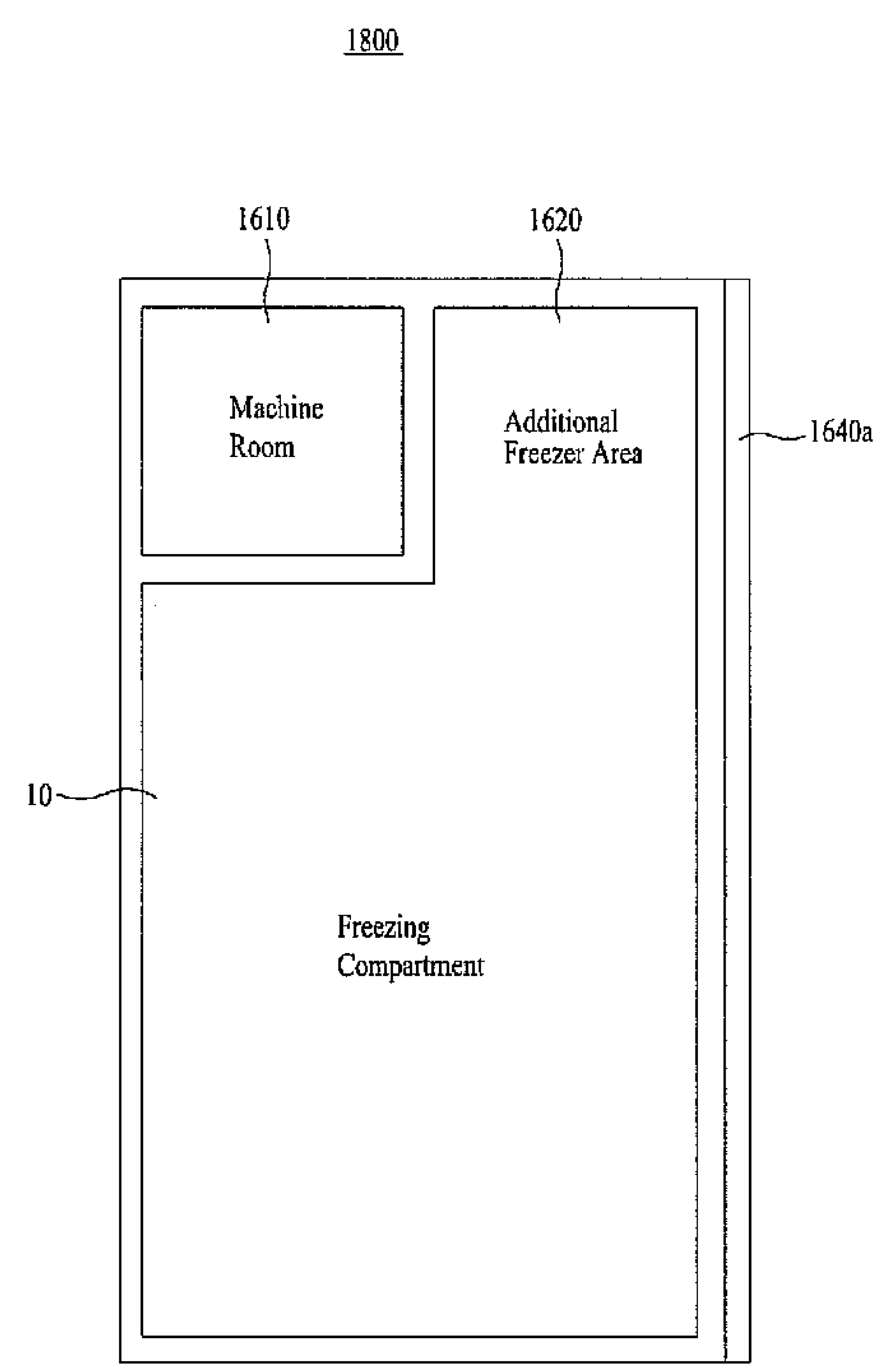

1800
1610
1620
Machine Room
Additional Freezer Area
1640a
10
Freezing Compartment

FIG. 19

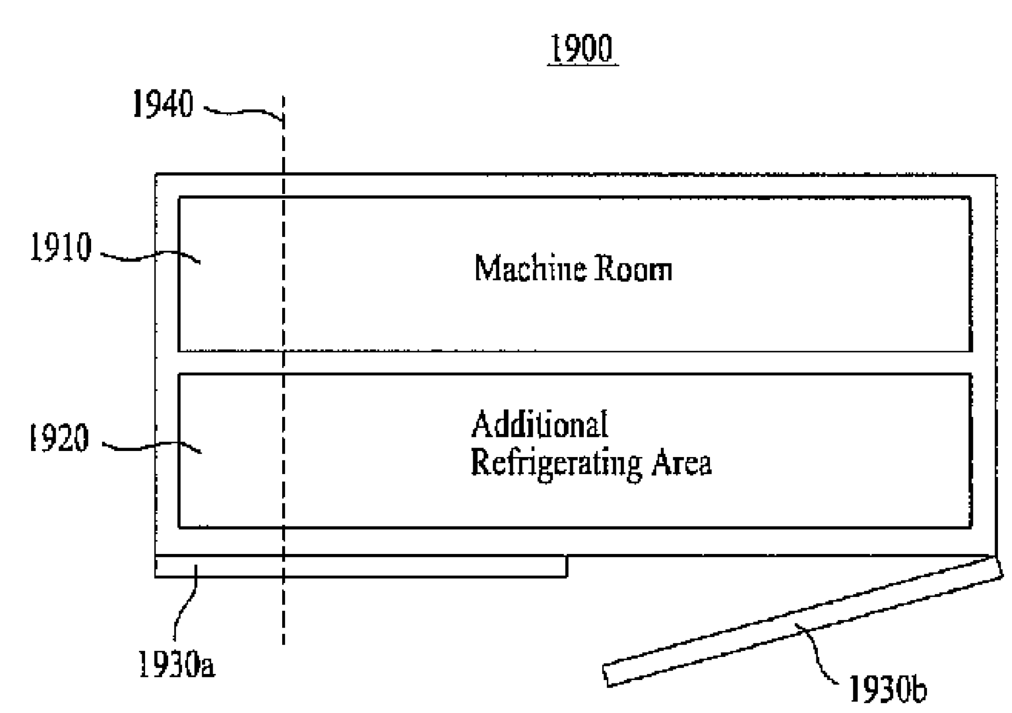

1900
1940
1910
Machine Room
1920
Additional
Refrigerating Area
1930a
1930b

FIG. 20

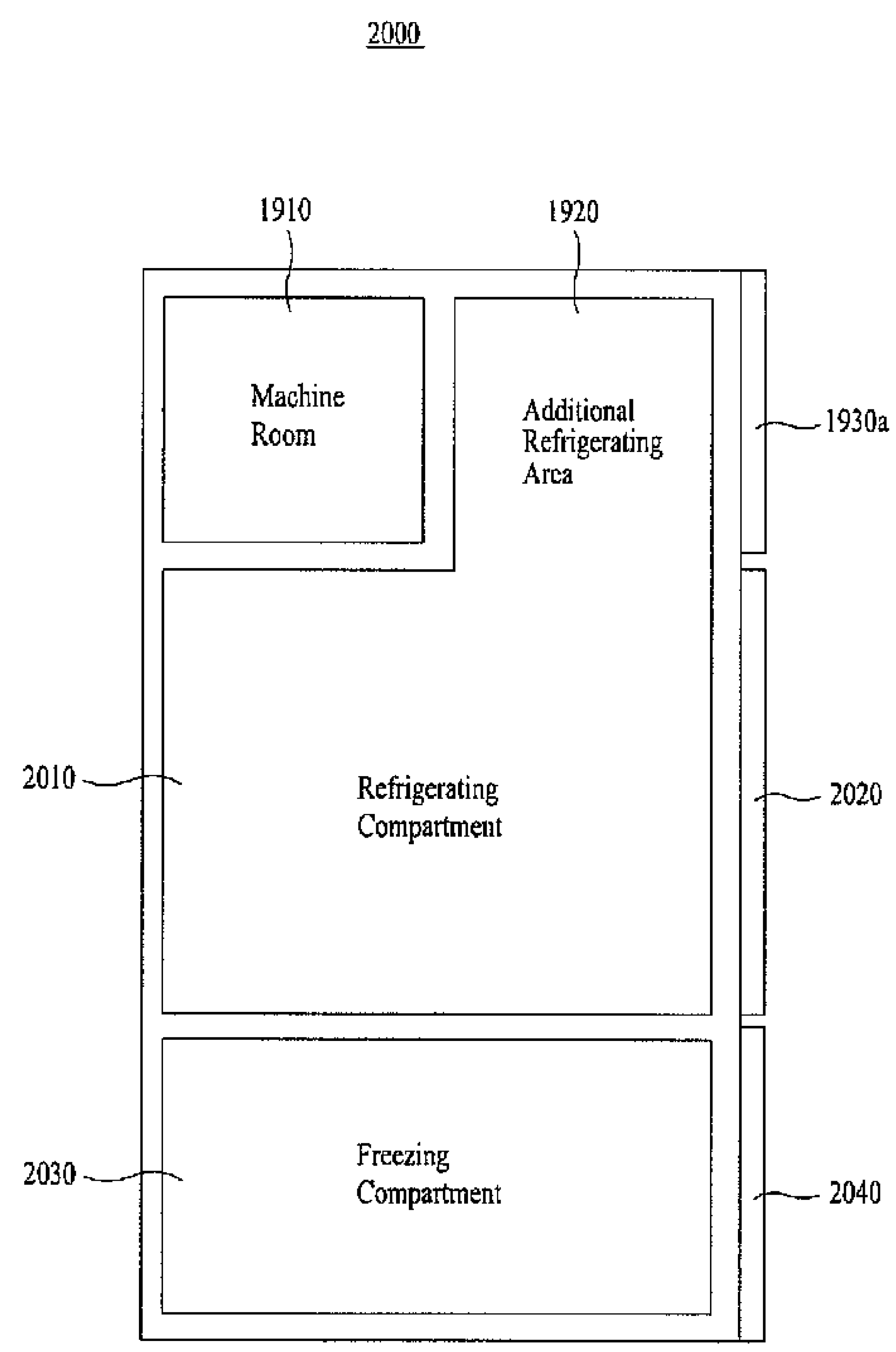
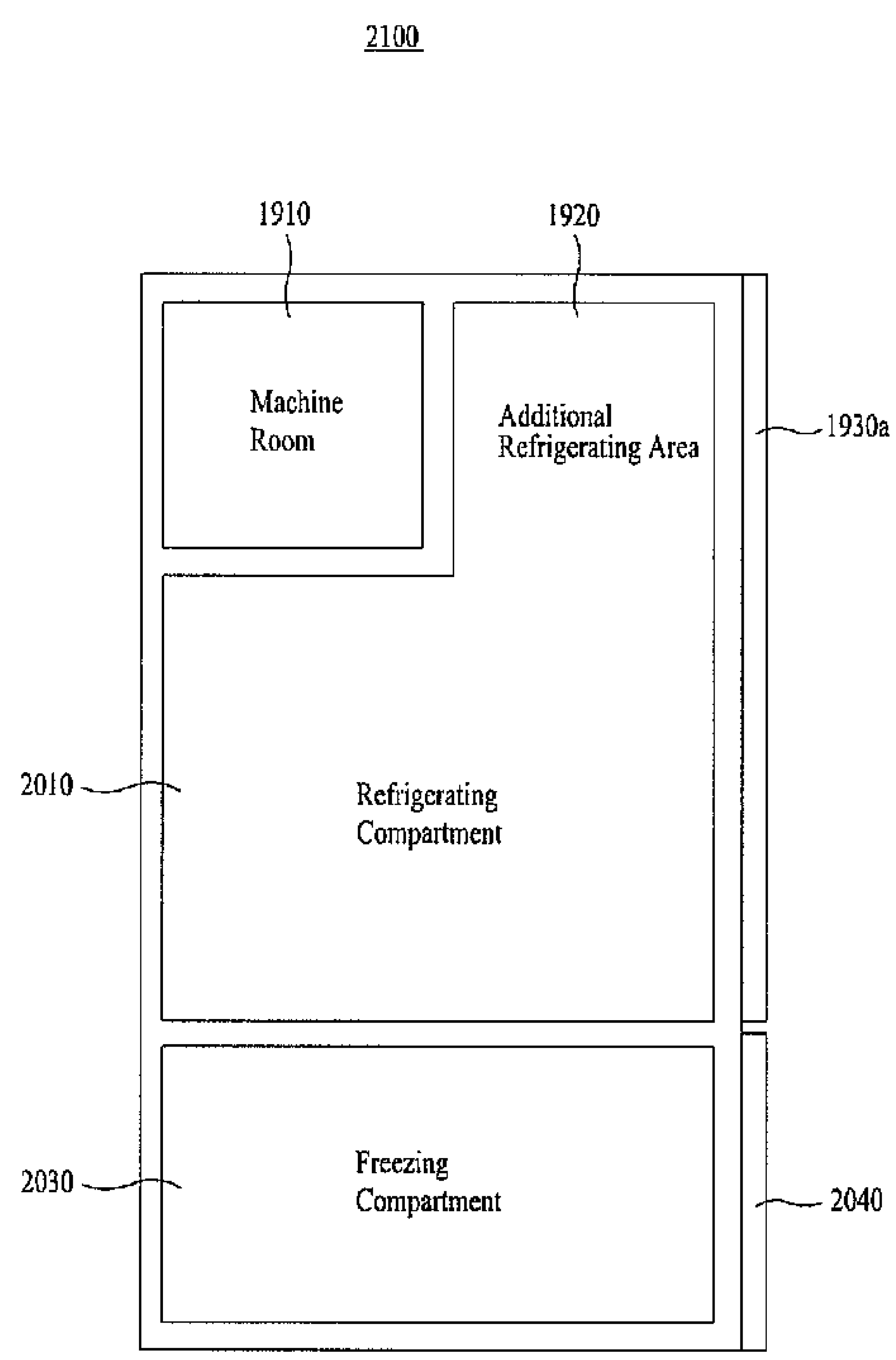

2000
1910
1920
Machine Room
Additional Refrigerating Area
1930a
2010
Refrigerating Compartment
2020
2030
Freezing Compartment
2040

FIG. 21


2100
1910
1920
Machine Room
Additional Refrigerating Area
1930a
2010
Refrigerating Compartment
2030
Freezing Compartment
2040

REFRIGERATOR HAVING COLD AIR GENERATING COMPARTMENT AND MACHINE ROOM POSITIONED AT UPPER PORTION OF CABINET

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of Korean Patent Application No. 10-2009-0007298, filed on, Jan. 30, 2009, which is hereby incorporated by reference as if fully set forth herein.

FIELD

The present disclosure relates to refrigerator technology.

BACKGROUND

Refrigerators are home appliances that are able to freeze or preserve fresh foods, such as meats, fruits, beverages, and the like, in predetermined storage compartments, using a four-step-cycle of compressing, condensing, expanding and evaporating refrigerant. Such a refrigerator may have a cabinet including a storage compartment, a door coupled to the cabinet to open and close the storage compartment, a cold air generating compartment accommodating an evaporator to generate cold air, and a machine compartment accommodating components, such as a compressor and a condenser and the like.

According to some configurations of a refrigerator, the cold air generating compartment is provided in a rear of the storage compartment. For example, a refrigerating compartment or freezing compartment and the cold air generating compartment are partitioned by a partition wall. The machine compartment is provided in a rear portion under the storage compartment.

SUMMARY OF THE DISCLOSURE

In one aspect, a refrigerator includes a cabinet, a storage compartment defined by the cabinet and having a top surface that defines a top of the storage compartment when the cabinet is oriented in an ordinary operating orientation, and an evaporator positioned at an upper portion of the cabinet and configured to generate cold air supplied to the storage compartment. The upper portion of the cabinet is located at a vertical position that is higher than the top surface of the storage compartment when the cabinet is oriented in the ordinary operating orientation. The refrigerator also includes a unit configured to control supply of cold air generated by the evaporator to the storage compartment.

Implementations may include one or more of the following features. For example, the refrigerator may include a cold air generating compartment that is positioned at the upper portion of the cabinet, that is in communication with the storage compartment, and that is configured to accommodate the evaporator. In this example, the refrigerator may include a cold air outlet positioned between the cold air generating compartment and the storage compartment and configured to guide cold air generated by the evaporator toward the storage compartment. The refrigerator also may include a cold air fan configured to promote movement of cold air generated by the evaporator through the cold air outlet and into the storage compartment. The unit may be configured to control supply of cold air through the cold air outlet.

In addition, the storage compartment may be a refrigerating compartment and the refrigerator may include a freezing

compartment defined by the cabinet in parallel with the refrigerating compartment. The cold air generating compartment may be in communication with the freezing compartment and the refrigerating compartment.

In some examples, the cold air outlet may be a first cold air outlet in communication with the refrigerating compartment and the unit may be a first unit configured to control supply of cold air through the first cold air outlet. In these examples, the refrigerator may include a second cold air outlet positioned between the cold air generating compartment and the freezing compartment and configured to guide cold air generated by the evaporator toward the freezing compartment and a second unit configured to control supply of cold air through the second cold air outlet.

In some implementations, the refrigerator may include a first return duct that connects the refrigerating compartment with the cold air generating compartment and that is configured to guide air from inside of the refrigerating compartment toward the cold air generating compartment. The refrigerator also may include a second return duct that connects the freezing compartment with the cold air generating compartment and that is configured to guide air from inside of the freezing compartment toward the cold air generating compartment. In these implementations, the refrigerator may include a first return unit configured to control air flow through the first return duct and a second return unit configured to control air flow through the second return duct.

Further, the refrigerator may include a return duct that connects each of the refrigerating compartment and the freezing compartment with the cold air generating compartment. The return duct may be configured to guide air from inside each of the refrigerating compartment and the freezing compartment toward the cold air generating compartment and may be positioned in a barrier between the refrigerating compartment and the freezing compartment.

The refrigerator may include a control unit configured to perform operations that include accessing a first temperature measurement for the refrigerating compartment and accessing a second temperature measurement for the freezing compartment. The operations also may include comparing the first temperature measurement to a first temperature threshold, comparing the second temperature measurement to a second temperature threshold, and determining whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold based on the comparisons. The operations further may include controlling the first unit and the second unit to supply cold air generated by the evaporator to the refrigerating compartment only, the freezing compartment only, or both the refrigerating compartment and the freezing compartment based on the determination of whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold.

The refrigerator may include a machine room positioned at the upper portion of the cabinet adjacent the cold air generating chamber and a compressor positioned in the machine room. The machine room may be positioned above only the refrigerating compartment and the cold air generating chamber may be positioned above both the refrigerating compartment and the freezing compartment. The refrigerator may include a return duct that connects the storage compartment with the cold air generating compartment and that is configured to guide air from inside of the storage compartment toward the cold air generating compartment and a return unit configured to control air flow through the return duct.

In another aspect, a refrigerator includes a cabinet and a refrigerating compartment defined by the cabinet and having a surface that defines a top of at least one portion of the refrigerating compartment when the cabinet is oriented in an ordinary operating orientation. The refrigerator also includes a machine room having one or more compartments and being positioned at an upper portion of the cabinet. The upper portion of the cabinet is located at a vertical position that is higher than the surface of the refrigerating compartment when the cabinet is oriented in the ordinary operating orientation and the machine room occupies less than all of the upper portion of the cabinet. The refrigerator further includes one or more components of a heat exchange cycle that is configured to regulate temperature of the refrigerating compartment. The one or more components are positioned in the machine room. In addition, the refrigerator includes an additional storage compartment that is positioned at the upper portion of the cabinet adjacent to the machine room, that is separated from the machine room by at least one wall, and that includes an access opening that is configured to enable placement of items in and removal of items from the additional storage compartment. The refrigerator also includes at least one door configured to open and close the access opening of the additional storage compartment.

Implementations may include one or more of the following features. For example, the refrigerator may include a freezing compartment defined by the cabinet in parallel with the refrigerating compartment and having a surface that defines a top of the freezing compartment when the cabinet is oriented in an ordinary operating orientation. The surface of the freezing compartment may be located in a plane with the surface of the refrigerating compartment. The additional storage compartment may be positioned above only the freezing compartment and may be partitioned from the machine room by at least one wall that extends along an entire depth of the cabinet.

In some examples, the additional storage compartment may extend along an entire horizontal width of the cabinet, may be partitioned from the machine room by at least one wall that extends along an entire horizontal width of the cabinet, and may occupy a front portion of a depth of the upper portion of the cabinet. In these examples, the machine room occupy a rear portion of the depth of the upper portion of the cabinet. Further, at least a portion of the additional storage compartment may include an additional portion of the refrigerating compartment provided at the upper portion of the cabinet.

In yet another aspect, a control method of regulating temperature in a refrigerator includes supplying cold air to a refrigerating compartment and a freezing compartment. The cold air is generated by an evaporator positioned at an upper portion of a cabinet that defines the refrigerating compartment and the freezing compartment and the upper portion of the cabinet is located at a vertical position that is higher than the refrigerating compartment and the freezing compartment when the cabinet is oriented in an ordinary operating orientation. The method also includes accessing a first temperature measurement for the refrigerating compartment and accessing a second temperature measurement for the freezing compartment. The method further includes comparing the first temperature measurement to a first temperature threshold, comparing the second temperature measurement to a second temperature threshold, and determining whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold based on the comparisons. In addition, the method includes controlling flow of cold air generated by the evaporator to the refrigerating compartment, the freezing compartment, or both the refrigerating compartment and the freezing compartment based on the determination of whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold.

Implementations may include one or more of the following features. For example, the method may include controlling a first unit to open or close a first air flow passage between the refrigerating compartment and a cold air generating compartment configured to accommodate the evaporator and controlling a second unit to open or close a second air flow passage between the freezing compartment and the cold air generating compartment.

In some implementations, the method may include, based on a determination that the first temperature measurement for the refrigerating compartment is above the first temperature threshold and the second temperature measurement for the freezing compartment is below the second temperature threshold, allowing flow of cold air generated by the evaporator to the refrigerating compartment and stopping flow of cold air generated by the evaporator to the freezing compartment. The method also may include, based on a determination that the first temperature measurement for the refrigerating compartment is below the first temperature threshold and the second temperature measurement for the freezing compartment is above the second temperature threshold, stopping flow of cold air generated by the evaporator to the refrigerating compartment and allowing flow of cold air generated by the evaporator to the freezing compartment.

The method further may include, based on a determination that the first temperature measurement for the refrigerating compartment is below the first temperature threshold and the second temperature measurement for the freezing compartment is below the second temperature threshold, allowing flow of cold air generated by the evaporator to the refrigerating compartment and allowing flow of cold air generated by the evaporator to the freezing compartment. In addition, the method may include, based on a determination that the first temperature measurement for the refrigerating compartment is above the first temperature threshold and the second temperature measurement for the freezing compartment is above the second temperature threshold, allowing flow of cold air generated by the evaporator to the refrigerating compartment and allowing flow of cold air generated by the evaporator to the freezing compartment.

In some examples, the method may include monitoring a refrigerating compartment door position, a duration of when the refrigerating compartment door is oriented in an opened position, and a number of times the refrigerating compartment door has been opened in a first time period and monitoring a freezing compartment door position, a duration of when the freezing compartment door is oriented in an opened position, and a number of times the freezing compartment door has been opened in a second time period. In these examples, the method may include controlling flow of cold air generated by the evaporator to the refrigerating compartment, the freezing compartment, or both the refrigerating compartment and the freezing compartment based on the determination of whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold, based on the monitoring of the refrigerating compartment door position, the duration of when the refrigerating compartment door is oriented in the opened position, and the number of times the refrigerating compartment door has been opened in the first time period, and based on the monitoring of the freezing compartment door position, the duration of when the freezing compartment door is oriented in the opened position, and the number of times the freezing compartment door has been opened in the second time period.

Further, the method may include monitoring an amount of time that cold air generated by the evaporator has been controlled to flow to only a single compartment. The method may include controlling flow of cold air generated by the evaporator to the refrigerating compartment, the freezing compartment, or both the refrigerating compartment and the freezing compartment based on the determination of whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold and based on the monitoring of the amount of time that cold air generated by the evaporator has been controlled to flow to only a single compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view illustrating a refrigerator;

FIG. **2** is an exploded perspective view illustrating a cold air generating compartment of the refrigerator;

FIG. **3** is an exploded perspective view illustrating a machine compartment of the refrigerator;

FIG. **4** is a perspective view illustrating a guiding duct installed in the refrigerator;

FIG. **5** is a front view illustrating cold air supplied to a freezing compartment and a refrigerating compartment provided in the refrigerator;

FIG. **6** is a front view illustrating cold air supplied to the refrigerating compartment;

FIG. **7** is a front view illustrating cold air supplied to the freezing compartment;

FIG. **8** is a front view illustrating an example refrigerator;

FIG. **9** is a front view illustrating an example refrigerator;

FIG. **10** is a flow chart illustrating an example control method of a refrigerator;

FIG. **11** is a flow chart illustrating an example control method of a refrigerator;

FIG. **12** is a table illustrating example logic for the example control method shown in FIG. **11**;

FIG. **13** is a perspective view illustrating a storage device installed in a refrigerator;

FIG. **14** is a top view illustrating an example refrigerator;

FIG. **15** is a side view illustrating a cross-section of the example refrigerator shown in FIG. **14** taken along line **1440**;

FIG. **16** is a top view illustrating an example refrigerator;

FIG. **17** is a side view illustrating an example cross-section of the example refrigerator shown in FIG. **16** taken along line **1650**;

FIG. **18** is a side view illustrating another example cross-section of the example refrigerator shown in FIG. **16** taken along line **1650**;

FIG. **19** is a top view illustrating an example refrigerator;

FIG. **20** is a side view illustrating an example cross-section of the example refrigerator shown in FIG. **19** taken along line **1940**; and

FIG. **21** is a side view illustrating another example cross-section of the example refrigerator shown in FIG. **19** taken along line **1940**.

DETAILED DESCRIPTION

Techniques are described for arranging a machine room of a refrigerator at an uppermost part of a refrigerator body. By arranging the machine room at an uppermost part of the refrigerator body, a size of a refrigerating compartment and/or a freezing compartment may be increased because usable space of the refrigerating compartment and/or the freezing compartment is not taken up by the machine room and its components. For example, the machine room may be positioned at a relatively high location that is outside of a typical user's reach. In this example, because the machine is positioned outside of a typical user's reach and at a position that is not suitable for a refrigerating compartment and/or freezing compartment, the machine room does not take up space that is otherwise usable for the refrigerating compartment and/or the freezing compartment.

In some implementations, the machine room is vertically-partitioned into multiple cabinets or compartments across an uppermost part of a refrigerator body. In these implementations, when the refrigerator is a side-by-side type having a freezing compartment and a refrigerating compartment arranged side-by-side, a central cool air generation compartment may be part of the machine room and configured to distribute cool air to the freezing compartment and the refrigerating compartment (e.g., both sides of the refrigerator). In addition, when the refrigerator is the side-by-side type, heat producing components of the machine room (e.g., compressor) may be housed in a vertically-partitioned compartment that is positioned over the refrigerating compartment instead of the freezing compartment. Arranging the heat producing components of the machine room over only the refrigerating compartment (or having a majority of an area taken up by the heat producing components of the machine room being positioned over the refrigerating compartment rather than the freezing compartment) may lead to improved efficiency in cooling the refrigerator and energy savings. Moreover, a negative impact caused by an overheating failure of one or more of the heat producing components may be reduced when the failing component is positioned over the refrigerating compartment instead of freezing compartment because the additional heat generated by the failing component is less likely to spoil food in the refrigerating compartment.

In some examples, components of the machine room may not require the machine room to occupy an entirety of an uppermost portion of a refrigerator body. In these examples, the additional space of the uppermost portion of the refrigerator body that is not taken up by the machine room may be used to provide additional functionality. For instance, the additional space may be used as an additional storage compartment that is not cooled by the refrigerator or the additional space may be used as additional space for a refrigerating and/or freezing compartment of the refrigerator.

FIG. **1** illustrates an example of a refrigerator that is oriented in an ordinary operating orientation. As shown in FIG. **1**, a refrigerator includes a cabinet **1** having at least one storage compartment. As shown, the refrigerator includes a freezing compartment **10**, a refrigerating compartment **20**, and a cold air generating compartment **100** provided in an upper portion of the cabinet **1**. The cold air generating compartment **100** is configured to supply cold air to each of the freezing compartment **10** and the refrigerating compartment **20**.

In some examples, the freezing compartment **10** and the refrigerating compartment **20** are partitioned by a partition wall **25** and they are arranged side-by-side in parallel. In other examples, the freezing compartment **10** and the refrigerating compartment **20** have other orientations, such as a stacked configuration with an upper freezing compartment **10** and a lower refrigerating compartment **20** or a lower freezing compartment **10** and an upper refrigerating compartment **20**.

A machine compartment **300** is positioned adjacent to the cold air generating compartment **100**. The machine compartment **300** accommodates a compressor **310**, a condenser **320**, and a condensation fan **330**. The machine compartment **300** has a first machine compartment **300***a* positioned next to the cold air generating compartment **100** and a second machine compartment **300***b* positioned next to the cold air generating compartment **100** on the opposite side. The first machine compartment **300***a* accommodates the condenser **320** and the condensation fan **330**. The second machine compartment **300***b* accommodates the compressor **310**.

Alternatively, a single machine compartment **300**, instead of plural ones, may be provided in a predetermined portion of the cold air generating compartment **100**. In this example, the single machine compartment **300** includes the compressor **310**, the condenser **320**, and the condensation fan **330**.

As to an exterior appearance of the refrigerator, the height of the cold air generating compartment **100** may be identical to that of the machine compartment **300**.

An evaporator **110** may be positioned within the cold air generating compartment **100** and configured to generate cold air. Cold air outlets **125***a* and **125***b* are defined between the cold air generating compartment **100** and the freezing compartment **10** and between the cold air generating compartment **100** and the refrigerating compartment **20**, respectively. The cold air outlets **125***a* and **125***b* guide the cold air generated by the evaporator **110** toward the freezing and refrigerating compartments **10** and **20**, respectively.

A water collecting tray **150** may be provided between the cold air outlets **125***a* and **125***b* and the evaporator **110** to receive defrost water generated by the evaporator **110**. A cold air guiding recess **155** may be provided in the water collecting tray **150** to guide the cold air of the evaporator **110** toward the cold air outlets **125***a* and **125***b*.

Cold air fans **115***a* and **115***b* are positioned in the first and second cold air outlets **125***a* and **125***b*, respectively. The cold air fans **115***a* and **115***b* are configured to blow the cold air generated by the evaporator **110** into the freezing and refrigerating compartments **10** and **20**, respectively.

The cold air outlets **125***a* and **125***b* may be a first cold air outlet **125***a* and a second cold air outlet **125***b* and the cold air fans **115***a* and **115***b* may be a first cold air fan **115***a* corresponding to the first cold air outlet **125***a* and a second cold air fan **115***b* corresponding to the second cold air outlet **125***b*. The cold air fans **115***a* and **115***b* may each be a cross-flow fan.

A closable damper **126***a* and **126***b* is positioned in each of the first and second cold air outlets **125***a* and **125***b*, respectively. The closable dampers **126***a* and **126***b* open and close the first and second cold air outlets **125***a* and **125***b*, respectively, such that cold air inside the cold air generating compartment **100** may be stopped from moving into the freezing or refrigerating compartment **10** or **20**.

The closable dampers **126***a* and **126***b* include a first closable damper **126***a* provided in the first cold air outlet **125***a* and a second closable damper **126***b* provided in the second cold air outlet **125***b*.

In some implementations, the first closable damper **126***a* is rotatably mounted between the water collecting tray **150** and the first cold air fan **115***a* and the second closable damper **126***b* is rotatably mounted between the water collecting tray **150** and the second cold air fan **115***b*.

Alternatively, the first and second closable dampers **126***a* and **126***b* may be mounted under the first and second cold air fans **115***a* and **115***b*, respectively.

In some examples, the first and second cold air fans **115***a* and **115***b* are positioned directly under the cold air guiding recess **155** and installed in centers of the first and second cold air outlets **125***a* and **125***b*, respectively.

When the first and second cold air fans **115***a* and **115***b* rotate, cold air generated by the evaporator **110** is drawn by the first and second cold air fans **115***a* and **115***b* toward the freezing compartment **10** and refrigerating compartment **20**, respectively. The cold air moves vertically downward into the freezing compartment **10** and refrigerating compartment **20** after passing the first and second cold air fans **115***a* and **115***b*, respectively.

Because the first and second cold air fans **115***a* and **115***b* rotate, some of the cold air moves vertically downward along the partition wall **25** and the other flows along the rotation direction such that the cold air may be supplied to the freezing and refrigerating compartments **10** and **20** uniformly.

Cold air inlets **120***a* and **120***b* may be defined in sides of the cold air generating compartment **100**. The cold air inlets **120***a* and **120***b* draw cold air having passed through the freezing and refrigerating compartments **10** and **20** into the cold air generating compartment **100**.

The cold air inlets **120***a* and **120***b* are each connected with a guiding duct **130***a* and **130***b* that guides the flow of the cold air inside the freezing and refrigerating compartments **10** and **20**. The guiding ducts **130***a* and **130***b* may include a first guiding duct **130***a* connecting the freezing compartment **10** with the cold air generating compartment **100** and a second guiding duct **130***b* connecting the refrigerating compartment **20** with the cold air generating compartment **100**.

The first and second guiding ducts **130***a* and **130***b* are arranged along side and upper walls of the freezing and refrigerating compartments **10** and **20** and side walls of the cold air generating compartment **100**.

The cold air inlets **120***a* and **120***b* include a first cold air inlet **120***a* that draws cold air of the freezing compartment **10** and a second cold air inlet **120***b* that draws cold air of the refrigerating compartment **20**.

First and second dampers **121***a* and **121***b* are positioned at the first and second cold air inlets **120***a* and **120***b*, respectively. The first and second dampers **121***a* and **121***b* are configured to open and close the first and second cold air inlets **120***a* and **120***b*, respectively, to selectively stop cold air moving into the cold air generating compartment **100** from the freezing or refrigerating compartment **10** or **20**.

According to the inner structure of the cold air generating compartment **100** as shown in FIG. **2**, the first and second cold air outlets **125***a* and **125***b* are defined in a bottom wall of the cold air generating compartment **100** such that the freezing compartment **10** may be in communication with the refrigerating compartment **20**.

The first and second cold air fans **115***a* and **115***b* and the first and second closable dampers **126***a* and **126***b* are provided in the first and second cold air outlets **125***a* and **125***b*, respectively, as mentioned above. Driving members **116***a*, **116***b*, **127***a*, and **127***b* are provided in the first and second cold air fans **115***a* and **115***b* and the first and second closable dampers **126***a* and **126***b*, respectively, to drive the fans and closable dampers. The driving members **116***a*, **116***b*, **127***a*, and **127***b* may include motors. The first and second dampers **121***a* and **121***b* also include driving members **122***a* and **122***b* that drive the first and second dampers **121***a* and **121***b*, respectively.

The cold air generating compartment **100** may be provided over both of the freezing compartment **10** and the refrigerating compartment **20** to supply cold air of the cold air generating compartment **100** to both the freezing and refrigerating compartments **10** and **20** and, in some examples, uniformly.

The water collecting tray **150** may be provided over the first and second cold air outlets **125***a* and **125***b* and the cold air guiding recess **155** defined in the water collecting tray **150** may be positioned directly on (e.g., above) the first and second cold air outlets **125***a* and **125***b*.

In some implementations, a circumference of the cold air guiding recess **155** is surrounded by a projecting rib **156** to reduce (e.g., prevent) the defrost water collected in the water collecting tray **150** from leaking into the cold air guiding recess **155**.

The evaporator **110** is provided on the water collecting tray **150** and the evaporator **110** may have an approximately hexagonal shape.

The first and second cold air inlets **120***a* and **120***b* are positioned at both sides of the evaporator **110**, respectively. The first and second dampers **121***a* and **121***b* are positioned in the first and second cold air inlets **120***a* and **120***b*, respectively, as mentioned above.

The cold air generating compartment **100** is defined as an airtight space surrounded by insulation walls. The inlets and outlets are defined through the insulation walls to enable communication between the cold air generating compartment **100** and the freezing and refrigerating compartments **10** and **20**.

The first and second guiding ducts **130***a* and **130***b* are positioned in both sides of the insulation walls that define the cold air generating compartment **100**. The first and second cold air inlets **120***a* and **120***b* are defined at the end of the first and second guiding ducts **130***a* and **130***b*, respectively.

As shown in FIG. **3**, the first and second machine compartments **300***a* and **300***b* are positioned on both sides of the cold air generating compartment **100**. The condenser **320** and the condensation fan **330** are provided in the first machine compartment **300***a* and the compressor **310** is provided in the second machine compartment **300***b*.

The first and second machine compartments **300***a* and **300***b* are defined by first and second housings **340***a* and **340***b*, respectively. First and second cover members **345***a* and **345***b* are installed to fronts of the first and second housings **340***a* and **340***b*, respectively, to reduce exposure of the insides of the machine compartments **300***a* and **300***b* to the outside.

A plurality of communication holes **350***a* and **350***b* may be provided in the first and second cover members **345***a* and **345***b*, respectively, to communicate internal air of the machine compartment **300** (**300***a* and **300***b*) with external air.

As shown in FIG. **4**, the first guiding duct **130***a* is provided in the portion of the freezing compartment **10** and a first guiding hole **131***a* is defined at (e.g., in) an end portion of the first guiding duct **130***a* to draw air from inside the freezing compartment **10** into the first guiding duct **130***a*.

As a result, the air of the freezing compartment **10** drawn via the first guiding hole **131***a* flows along the first guiding duct **130***a* into the cold air generating compartment (**100**, see FIG. **1**). Then, the air is re-supplied to the freezing compartment **10** by the first cold air fan (**115***a*, see FIG. **1**) after passing the evaporator (**110**, see FIG. **1**).

This configuration and air circulation may be applicable to those of the refrigerating compartment **20**, the second guiding duct **130***b*, and the second guiding hole **131***b* (see FIG. **1**).

Examples of operation of the refrigerator are described below with respect to FIGS. **5**-**7**. As shown in FIG. **5**, once the compressor **310** operates, the refrigerant compressed by the compressor **310** flows into the condenser **320** in a state of the cold air being supplied to both of the freezing and refrigerating compartments **10** and **20**.

The refrigerant inside the condenser **320** is condensed through cooling operation performed by the condensation fan **330**. Then, the condensed refrigerant is decompressed and expanded through a predetermined expansion process, which results in low temperature and low pressure refrigerant. The low-temperature-and-low-pressure air is drawn into the evaporator **110**.

Next, the first and second closable dampers **126***a* and **126***b* and the first and second dampers **121***a* and **121***b* are opened, the first and second cold air fans **115***a* and **115***h* rotate, and the cold air that has passed over the evaporator **110** is supplied to the freezing and refrigerating compartments **10** and **20**.

The rotational direction of the first and second cold air fans **115***a* and **115***b* is toward each side of the partition wall **25** with respect to the front. As a result, the first cold air fan **115** provided in the freezing compartment **10** rotates in a clockwise direction and the second cold air fan **115***b* provided in the refrigerating compartment **20** rotates in a counter-clockwise direction.

Such rotation causes at least some of the cold air to move vertically downward along the partition wall **25**. The cold air moved vertically downward along the partition wall **25** is employed as an 'air curtain' and some of the cold air is supplied to the freezing and refrigerating compartments **10** and **20** uniformly.

The cold air supplied to the freezing and refrigerating compartments **10** and **20** moves to the lower portions of the freezing and refrigerating compartments **10** and **20**, and the cold air is re-supplied to the cold air generating compartment **100**, after being drawn into the first and second guiding ducts **130***a* and **130***b*.

Because the first and second cold air fans **115***a* and **115***b* are rotating continuously, the cold air generating compartment **100** is at a low pressure in comparison to the lower portion of the freezing or refrigerating compartment **10** or **20** and thus the air in the lower portion of the freezing or refrigerating compartment **10** or **20** moves into the cold air generating compartment **100** along the first and the second guiding duct **130***a* and **130***b*.

As shown in FIG. **6**, if the temperature inside the refrigerating compartment **20** increases suddenly out of a predetermined range kept by the normal supply of the cold air to the freezing and refrigerating compartments **10** and **20**, the refrigerator may be controlled to supply cold air to the refrigerating compartment **20** at a higher volume or intensity.

In this example, the first closable damper **126***a* for the freezing compartment **20** closes the first cold air outlet **125***a* and the operation of the first cold air fan **115***a* is stopped temporarily.

The open state of the second closable damper **126***b* and the operation of the second cold air fan **115***b* is maintained. Based on this configuration, the cold air having passed over the evaporator **110** is supplied to the refrigerating compartment **20** at a higher volume or intensity to decrease the temperature inside the refrigerating compartment **20** such that the temperature may return to the normal range.

If the temperature inside the refrigerating compartment **20** is in the normal range, the first cold air fan **115***a* re-operates and the first damper **126***a* is open to re-draw the cold air into the freezing compartment **10**.

FIG. **7** illustrates an opposite case to the case of FIG. **6**. Specifically, if a storing object having a relatively high temperature is put in the freezing compartment **10**, the temperature inside the freezing compartment **10** may increase drastically out of a predetermined range kept for the normal supply of the cold air to the freezing and refrigerating compartments **10** and **20**.

In this example, the refrigerator may be controlled to perform the intensive supply of cold air to the freezing compartment **10**.

For instance, the second closable damper **126***b* for the refrigerating compartment **20** closes the second cold air outlet **125***b* and the operation of the second cold air fan **115***b* is stopped temporarily.

The open state of the first closable damper **126***a* and the operation of the first cold air fan **125***a* is maintained. Based on this configuration, the cold air having passed over the evaporator **110** is supplied to the freezing compartment **10** at a higher volume or intensity and the temperature inside the freezing compartment **10** decreases such that the temperature inside the freezing compartment **10** may return to the normal range.

If the temperature inside the freezing compartment **10** is in the normal range, the second cold air fan **125***b* re-operates and the second closable damper **126***b* re-opens to re-draw the cold air into the refrigerating compartment **20**.

FIG. **8** illustrates another example of a refrigerator. As shown, instead of having separate guiding ducts **130***a* and **130***b* for the freezing and refrigerating compartments **10** and **20**, respectively, the refrigerator has a shared guiding duct **130***c* that guides are from each of the freezing and refrigerating compartments **10** and **20** to the cold air generating compartment **100**. The shared guiding duct **130***c* is positioned within the barrier **25** between the freezing and refrigerating compartments **10** and **20**. The shared guiding duct **130***c* includes a freezing compartment guiding hole **131***c* and a refrigerating compartment guiding hole **131***d*. The freezing compartment guiding hole **131***c* allows air from the freezing compartment **10** to enter the shared guiding duct **130***c* and the refrigerating compartment guiding hole **131***d* allows air from the refrigerating compartment **20** to enter the shared guiding duct **130***c*.

A cold air inlet **120***c* is defined in a bottom wall of the cold air generating compartment **100**. The cold air inlet **120***c* draws cold air having passed through the freezing and refrigerating compartments **10** and **20** into the cold air generating compartment **100**. The cold air inlet **120***c* is connected with the guiding duct **130***c*. The water collecting tray **150** includes an opening that corresponds to the cold air inlet **120***c* to enable air to pass into the cold air generating compartment **100** through the cold air inlet **120***c*.

A damper **121***c* is positioned at the cold air inlet **120***c*. The damper **121***c* is configured to open and close the cold air inlet **120***c* to selectively stop cold air moving into the cold air generating compartment **100** from the freezing and/or refrigerating compartments **10** and **20**.

FIG. **9** illustrates another example of a refrigerator having a shared guiding duct **130***c*. As shown, rather than interfacing with a cold air inlet defined in a bottom wall of the cold air generating compartment **100**, the shared guiding duct **130***c* interfaces with the cold air generating compartment **100** through a cold air inlet defined at an upper portion of a rear wall of the cold air generating compartment **100**. In this example, the shared guiding duct **130***c* runs behind the cold air generating compartment **100** to supply air to an upper portion of the cold air generating compartment **100**. Supplying air to the upper portion of the cold air generating compartment **100** may increase circulation and heat transfer and also does not require modification (e.g., reduction of an area covered by) the water collecting tray **150**.

A damper **121***d* is positioned at the cold air inlet defined at the upper portion of the rear wall of the cold air generating compartment **100**. The damper **121***d* is configured to open and close the cold air inlet to selectively stop cold air moving into the cold air generating compartment **100** from the freezing and/or refrigerating compartments **10** and **20**.

FIG. **10** illustrates an example control method of the above-described refrigerators. First, the compressor operates (S**100**) and cold air is supplied to the plurality of storage compartments, specifically, the freezing and refrigerating compartments (S**110**).

After the temperature inside each of the storage compartments is measured (S**120**), it is determined whether the temperature inside at least one storage compartment is over a predetermined temperature (S**130**).

The closable damper corresponding to the storage compartment having the temperature over the predetermined value is opened or maintained in an open state, if already open (S**140**) according to the result of the determination.

To supply the cold air at a higher volume or intensity to the storage compartment having the abnormal temperature, the closable damper corresponding to the other storage compartment is closed (S**150**).

If the temperature inside the storage compartment having the abnormal temperature distribution returns to a normal value, the refrigerator re-operates normally.

FIG. **11** illustrates another example process **1100** of controlling a refrigerator. The process **1100** accounts for temperature, door orientation measurements, and damper configuration measurements in controlling a damper configuration of a refrigerator. The process **1100** may be performed by a control unit (e.g., processor, computer, etc.) of a refrigerator.

The control unit detects a current damper configuration (**1110**). For example, the control unit detects whether a freezing compartment damper (e.g., damper **126***a*) that controls air flow to the freezing compartment is opened or closed and whether a refrigerating compartment damper (e.g., damper **126***b*) that controls air flow to the refrigerating compartment is opened or closed. The control unit may detect the current damper configuration by accessing data from one or more sensors configured to sense whether the freezing compartment damper is opened or closed and whether refrigerating compartment damper is opened or closed. The control unit may detect the current damper configuration by accessing stored data (e.g., one or more settings, one or more state variables, etc.) that indicates whether the freezing compartment damper has been controlled to be in an opened or closed position and whether the refrigerating compartment damper has been controlled to be in an opened or closed position.

The control unit monitors temperature of the refrigerating compartment (**1120**). For instance, the control unit accesses a temperature measurement from a temperature sensor configured to measure a temperature of the refrigerating compartment and compares the accessed temperature measurement to a range of one or more acceptable temperature measurements. Based on the comparison, the control unit determines whether the temperature measurement is within the range of one or more acceptable temperature measurements, below the range of one or more acceptable temperature measurements, or above the range of one or more acceptable temperature measurements. The control unit may periodically or continuously monitor a temperature of the refrigerating compartment.

The control unit monitors temperature of the freezing compartment (**1130**). For instance, the control unit monitors temperature of the freezing compartment using techniques similar to those described above with respect to reference numeral **1120**.

The control unit monitors a refrigerating compartment door position, a duration of when the refrigerating compartment door is oriented in an opened position, and/or a number of times the refrigerating compartment door has been opened in a given time period (**1140**). For instance, the control unit monitors a refrigerating compartment door position by accessing data from one or more sensors configured to sense whether the refrigerating compartment door is oriented in an opened position or a closed position. Based on the sensor data, the control unit determines whether the refrigerating compartment door is oriented in an opened position or a closed position. The control unit may periodically or continuously monitor a position of the refrigerating compartment door.

The control unit also monitors a duration of when the refrigerating compartment door is oriented in an opened position. For example, when the control unit first detects that the refrigerating compartment door has moved from a closed position to an opened position, the control unit may start a timer to measure a time that refrigerating compartment door remains opened or the control unit may log the time when the control unit detected that the refrigerating compartment door moved from a closed position to an opened position. When the control unit uses a timer to measure an open time of the refrigerating compartment door, the control unit periodically or continuously checks the timer to determine whether the refrigerating compartment door has been oriented in an opened position more than a threshold amount of time. When the control unit logs an opened time of the refrigerating compartment door, the control unit periodically or continuously compares the opened time to a current time to determine whether the refrigerating compartment door has been oriented in an opened position more than a threshold amount of time. When the control unit detects that the refrigerating compartment door has moved back to a closed position, the control unit ends monitoring of the door open duration, resets the monitoring data, and awaits another detection of the refrigerating compartment door moving from a closed position to an opened position.

The control unit further monitors a number of times the refrigerating compartment door has been opened in a given time period. For example, each time the control unit detects that the refrigerating compartment door has moved from a closed position to an opened position, the control unit updates data to track the door opening (e.g., increments a counter). The control unit may only consider detected door openings within a given past period of time (e.g., door openings in the last half hour or ten minutes) in determining the number. As time passes, the control unit reduces the number of detected door openings (e.g., decrements or resets a counter). The control unit periodically or continuously compares the number of door openings to a threshold number to determine whether the number of door openings exceeds the threshold.

The control unit monitors a freezing compartment door position, a duration of when the freezing compartment door is oriented in an opened position, and/or a number of times the freezing compartment door has been opened in a given time period (**1150**). For instance, the control unit monitors a freezing compartment door position, a duration of when the freezing compartment door is oriented in an opened position, and/or a number of times the freezing compartment door has been opened in a given time period using techniques similar to those described above with respect to reference numeral **1140**.

The control unit monitors an amount of time the dampers have been in a single compartment configuration (**1160**). For example, when the control unit controls the dampers to implement a single compartment configuration (e.g., only the refrigerating compartment or only the freezing compartment receives cooled air), the control unit may start a timer to measure a time that the single compartment configuration exists or the control unit may log the time when the control unit controlled the dampers to implement the single compartment configuration. When the control unit uses a timer to measure a single compartment configuration time, the control unit periodically or continuously checks the timer to determine whether the dampers have been oriented in a single compartment configuration more than a threshold amount of time. When the control unit logs a single compartment configuration start time, the control unit periodically or continuously compares the start time to a current time to determine whether the dampers have been oriented in a single compartment configuration more than a threshold amount of time. When the control unit controls the dampers to return to a dual compartment configuration, the control unit ends monitoring of the single compartment configuration, resets the monitoring data, and awaits another instance where the dampers are controlled to implement a single compartment configuration.

The control unit controls damper configuration based on the current damper configuration and one or more of the monitored properties (**1170**). For instance, the control unit controls the damper configuration based on the monitored temperature of the refrigerating compartment, the monitored temperature of the freezing compartment, the monitored door open position of the refrigerating compartment door, the monitored door open duration of the refrigerating compartment door, the monitored number of door openings of the refrigerating compartment door, the monitored door open position of the freezing compartment door, the monitored door open duration of the freezing compartment door, the monitored number of door openings of the freezing compartment door, and/or the monitored amount of time in a single compartment configuration.

In one example, the control unit determines that the monitored temperature of the freezing compartment exceeds a threshold temperature (e.g., has increased above a range of acceptable temperatures) and that the control unit should control the dampers to implement a freezing compartment only configuration to promote cooling of the freezing compartment. However, the control unit also determines that the freezing compartment door is oriented in an opened position (or has been oriented in an opened position for more than a threshold amount of time or has been opened more than a threshold number of times in the past ten minutes). To avoid sending a large amount of cool air through the opened door of the freezing compartment, the control unit determines not to control the dampers to implement a freezing compartment only configuration. Instead, in this example, the control unit controls the freezing compartment damper to close to reduce an amount of cooled air that escapes through the opened door of the freezing compartment. Accounting for the monitored door position (or other properties related to door monitoring), may improve the efficiency of the refrigerator and conserve energy.

In another example, the control unit has determined that the monitored temperature of the refrigerating compartment exceeds a threshold temperature (e.g., has increased above a range of acceptable temperatures) and has controlled the dampers to implement a refrigerating compartment only configuration to promote cooling of the refrigerating compartment. After implementing the refrigerating compartment only configuration, the control unit continues to monitor the temperature of the refrigerating compartment and monitors the amount of time the dampers have been oriented in the refrigerating compartment only configuration. Based on the continued monitoring, the control unit determines that the temperature of the refrigerating compartment remains above the threshold temperature and the damper configuration has been in the refrigerating compartment only configuration for more than a threshold amount of time. Based on this determination, the control unit determines that some aspect of cooling the refrigerating compartment appears to be malfunctioning. Accordingly, the control unit removes the refrigerating compartment only configuration and controls the dampers to implement a dual compartment configuration or a freezing compartment only configuration.

FIG. **12** illustrates example logic **1200** for controlling the damper configuration based on the current damper configuration and one or more of the monitored properties as described above with respect to reference numeral **1170**. As shown, the logic **1200** includes a current damper configuration column **1210**, a temperature column **1220**, a door position column **1230**, a door open duration column **1240**, a number of door openings column **1250**, an amount of time in a single compartment configuration column **1260**, and a set damper configuration column **1270**. The current damper configuration column **1210** stores values for a damper position (e.g., open or closed) of the freezing compartment damper and the refrigerating compartment damper. The values in the current damper configuration column **1210** are compared to detected damper configurations by the control unit.

The temperature column **1220** stores values for a temperature (e.g., within a proper operating range, below the proper operating range, or above the proper operating range) of the freezing compartment and the refrigerating compartment. The values in the temperature column **1220** are compared to monitored temperatures of the freezing and refrigerating compartments by the control unit. The door position column **1230** stores values for a door position (e.g., open or closed) of the freezing compartment door and the refrigerating compartment door. The values in the door position column **1230** are compared to monitored positions of the freezing and refrigerating compartment doors by the control unit.

The door open duration column **1240** stores values for a duration that the freezing compartment door and the refrigerating compartment door are oriented in an opened position (e.g., a particular duration or greater than/less than a limit threshold). The values in the door open duration column **1240** are compared to monitored open durations of the freezing and refrigerating compartment doors by the control unit. The number of door openings column **1250** stores values for a number of door openings (e.g., a particular number or greater than/less than a limit threshold) of the freezing compartment door and the refrigerating compartment door. The values in the number of door openings column **1250** are compared to monitored door openings of the freezing and refrigerating compartment doors by the control unit.

The amount of time in a single compartment configuration column **1260** stores values for an amount of time that the dampers are in a single compartment configuration (e.g., a particular amount of time or greater than/less than a limit threshold). The values in the amount of time in a single compartment configuration column **1260** are compared to monitored single compartment configuration times by the control unit.

The set damper configuration column **1270** indicates a damper configuration setting that the control unit uses when the monitored properties match a particular row in the logic **1200**. For instance, the control unit compares the monitored properties (e.g., temperature, door position, etc.) to the logic **1200** and, when the control unit finds a matching row, the control unit controls the dampers to have the configuration defined in the set damper configuration column **1270** for the matching row.

Although several example rows are shown in FIG. **12**, the logic **1200** may include more or fewer rows and have different configuration data or rules. In addition, the logic **1200** may include more or fewer columns of data. The logic **1200** is stored in electronic storage and accessed by the control unit in determining how to control the dampers.

Referring again to FIG. **11**, the control unit determines whether to provide an alert based on the current damper configuration and one or more of the monitored properties (**1180**). For instance, in certain circumstances, the control unit determines that a malfunction appears to have occurred or that a particular inefficiency is present. In these circumstances, the control unit provides an alert to a user to alert the user to the suspected malfunction or the particular inefficiency.

In one example, when the control unit determines that a temperature of the refrigerating compartment remains above a threshold temperature despite a damper configuration having been in the refrigerating compartment only configuration for more than a threshold amount of time, the control unit determines that a malfunction in some aspect of cooling the refrigerating compartment is likely. Based on the determination that a malfunction in some aspect of cooling the refrigerating compartment is likely, the control unit provides an alert to a user indicating that a malfunction of the refrigerating compartment is suspected. The alert may indicate that the temperature of the refrigerating compartment remained above the threshold temperature despite the damper configuration having been in the refrigerating compartment only configuration for more than the threshold amount of time.

In another example, when the control unit determines that the freezing compartment door has been oriented in an opened position for more than a threshold amount of time, the control unit provides an alert to a user indicating that an inefficiency exists. The alert may indicate that the freezing compartment door has been oriented in an opened position for more than a threshold amount of time. The alert also may indicate that cooling to the freezing compartment has been stopped because the freezing compartment door has been oriented in an opened position for more than a threshold amount of time.

The alerts provided by the control unit may be visual output provided on a display (e.g., a liquid crystal display (LCD) screen) and/or audible output provided by a speaker. When the refrigerator includes a network connection, the control unit may provide an alert in an electronic communication (e.g., an electronic mail message) over a network (e.g., the Internet).

FIG. **13** illustrates a refrigerator according to another example. As shown in FIG. **13**, the refrigerator is different from the above examples in which the machine compartment **300** is positioned on both sides of the cold air generating compartment **100**. Specifically, in this example, the machine compartment **300** is provided on a side of the cold air generating compartment **100** and a storage device **500** is provided on the other side of the cold air generating compartment **100**. The storage device **500** includes storage space **520** able to receive predetermined storing objects.

The storage device **500** includes a housing **510** defining the predetermined storage space **520** and a closable door **530** opening a front of the housing **510**.

In consideration to the exterior appearance of the refrigerator, the height of the storage device **500** may be identical to the heights of the cold air generating compartment **100** and the machine compartment **300**.

In other examples, instead of including the storage device **500**, the refrigerator may have an extended or enlarged freezing compartment. In these examples, the freezing compartment **10** may extend into the space on the other side of the cold air generating compartment **100** shown as being occupied by the storage device **500** in FIG. **13**. Accordingly, the additional space resulting from a smaller machine room may be used to increase capacity of the freezing compartment.

FIG. **14** illustrates an example refrigerator having a machine room that does not occupy an entire upper portion of a refrigerator body. In this example, the machine room **1410** is horizontally-partitioned in the upper portion of the refrigerator body. The machine room **1410** has been moved to a rear portion of the refrigerator body opposite of an access opening of the refrigerator and the doors of the refrigerator. Based on the positioning of the machine room **1410**, additional space in the upper portion of the refrigerator body remains across a front portion of the refrigerator body. In this example, a storage area or device **1420** is positioned in the additional space that is not occupied by the machine room **1410**. The storage area or device **1420** is not cooled and may be used by a user to store items, such as cookware, etc. The storage area or device **1420** is opened and closed by a pair of doors **1430***a* and **1430***b*. Although the pair of doors **1430***a* and **1430***b* are shown as being coupled to the refrigerator by hinges, the pair of doors **1430***a* and **1430***b* also may slide or being configured to tilt up and down.

FIG. **15** illustrates a cross-section of the example refrigerator shown in FIG. **14** taken along line **1440**. As shown, the machine room **1410** and the storage area or device **1420** are positioned at an upper portion of the refrigerator body above the freezing compartment and are horizontally partitioned. The machine room **1410** is positioned at a rear of the upper portion of the refrigerator body and the storage area or device **1420** is positioned at a front of the upper portion of the refrigerator body.

FIG. **16** illustrates another example refrigerator having a machine room that does not occupy an entire upper portion of a refrigerator body. In this example, the machine room **1610** is horizontally-partitioned in the upper portion of the refrigerator body. The machine room **1610** has been moved to a rear portion of the refrigerator body opposite of an access opening of the refrigerator and the doors of the refrigerator. Based on the positioning of the machine room **1610**, additional space in the upper portion of the refrigerator body remains across a front portion of the refrigerator body. In this example, an additional freezer area **1620** and an additional refrigerating area **1630** are positioned in the additional space that is not occupied by the machine room **1610**. The additional freezer area **1620** provides additional freezing compartment **10** space and the additional refrigerating area **1630** provides additional refrigerating compartment **20** space. The additional freezer area **1620** is opened and closed by a first door **1640***a* and the additional refrigerating area **1630** is opened and closed by a second door **1640***b*.

FIG. **17** illustrates a cross-section of the example refrigerator shown in FIG. **16** taken along line **1650**. As shown, the machine room **1610** and the additional freezer area **1620** are positioned at an upper portion of the refrigerator body and are horizontally partitioned. The machine room **1610** is positioned at a rear of the upper portion of the refrigerator body and the additional freezer area **1620** is positioned at a front of the upper portion of the refrigerator body. The additional freezer area **1620** is an extension of the freezing compartment **10**. In some implementations, an ice maker and/or an ice storage bin may be positioned in the additional freezer area **1620**. As shown in FIG. **17**, the door **1640***a* opens and closes only the additional freezer area **1620** and another freezing compartment door is provided.

FIG. **18** illustrates another example cross-section of the example refrigerator shown in FIG. **16** taken along line **1650**. In this example, the door **1640***a* opens and closes the additional freezer area **1620** and a remainder of the freezing compartment **10**.

FIG. **19** illustrates an example of a bottom freezer type refrigerator having a machine room that does not occupy an entire upper portion of a refrigerator body. In this example, the machine room **1910** is horizontally-partitioned in the upper portion of the refrigerator body. The machine room **1910** has been moved to a rear portion of the refrigerator body opposite of an access opening of the refrigerator and the doors of the refrigerator. Based on the positioning of the machine room **1910**, additional space in the upper portion of the refrigerator body remains across a front portion of the refrigerator body. In this example, an additional refrigerating area **1920** is positioned in the additional space that is not occupied by the machine room **1910**. The additional refrigerating area **1920** provides additional refrigerating compartment space. The additional refrigerating area **1920** is opened and closed by a pair of doors **1930***a* and **1930***b*. Although the pair of doors **1930***a* and **1930***b* are shown as being coupled to the refrigerator by hinges, the pair of doors **1930***a* and **1930***b* also may slide or being configured to tilt up and down.

FIG. **20** illustrates a cross-section of the example refrigerator shown in FIG. **19** taken along line **1940**. As shown, the machine room **1910** and the additional refrigerating area **1920** are positioned at an upper portion of the refrigerator body and are horizontally partitioned. The machine room **1910** is positioned at a rear of the upper portion of the refrigerator body and the additional refrigerating area **1920** is positioned at a front of the upper portion of the refrigerator body. The additional refrigerating area **1920** is an extension of a refrigerating compartment **2010**. As shown in FIG. **20**, the door **1930***a* opens and closes only the additional refrigerating area **1920** and another refrigerating compartment door **2020** is provided to open and close the remainder of the refrigerating compartment **2010**.

The refrigerator also includes a freezing compartment **2030** positioned at a lower portion of the refrigerator body. The freezing compartment **2030** is opened and closed by a freezing compartment door **2040**. Because the machine room **1910** is positioned at an upper portion of the refrigerator body, the refrigerator includes one or more ducts that guide air between the machine room (e.g., an evaporator in the machine room) and the freezing compartment **2030**.

In some examples, an additional evaporator may be positioned in the freezing compartment **2030** (or a wall of the freezing compartment **2030**). In these examples, because the machine room **1910** is positioned at an upper portion of the refrigerator body, coolant lines run between the additional evaporator and the machine room **1910**.

FIG. **21** illustrates another example cross-section of the example refrigerator shown in FIG. **19** taken along line **1940**. In this example, the door **1930***a* opens and closes the additional refrigerating area **1920** and a remainder of the refrigerating compartment **2010**.

In some implementations, the machine compartment is positioned in the upper portion of the cabinet. As a result, enlarged space may be secured in comparison with inner space of the conventional freezing or refrigerating compartment and thus storage space for storing objects may be enlarged.

Furthermore, some part of the cold air generating compartment may be provided in the upper portion of the cabinet. As a result, the forward-and-rearward width of the refrigerator may be reduced and this may result in a slim look of the refrigerator. In addition, the indoor area occupied by the refrigerator may be reduced and the utilization of the indoor space may be efficient.

In some examples, if the temperature inside at least one of the plural storage compartments changes abnormally, the cold air may be supplied to the storage compartment having the abnormal temperature change quickly and intensively. As a result, the freezing or refrigerating operation of the refrigerator may be performed not only efficiently, but also quickly.

In some implementations, the cold air may be supplied to a plurality of storage compartments by using a single evaporator. If desirable, the supply of the cold air may be performed for a specific one of the storage compartments intensively. As a result, more efficient cold air operation is possible.

It will be understood that various modifications may be made without departing from the spirit and scope of the claims. For example, advantageous results still could be achieved if steps of the disclosed techniques were performed in a different order and/or if components in the disclosed systems were combined in a different manner and/or replaced or supplemented by other components. Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. A refrigerator comprising:

a cabinet;

a storage compartment defined by the cabinet and having a top surface that defines a top of the storage compartment, the storage compartment comprising a freezing compartment and a refrigerating compartment separated by a partition wall and arranged side-by-side in parallel;

a cold air generating compartment that is positioned at an upper portion of the cabinet and that is in communication with the storage compartment, the upper portion of the cabinet being located at a vertical position that is higher than the top surface of the storage compartment;

a machine room positioned at the upper portion of the cabinet and adjacent the cold air generating compartment, the machine room comprising:

a first machine compartment provided on one side of the cold air generating compartment, wherein a condenser is installed in the first machine compartment; and

a second machine compartment provided on the other side of the cold air generating compartment, wherein a compressor is installed in the second machine compartment;

an evaporator provided in the cold air generating compartment and configured to generate cold air supplied to the storage compartment;

a first cold air outlet positioned between the cold air generating compartment and the freezing compartment and configured to guide cold air generated by the evaporator toward the freezing compartment;

a second cold air outlet positioned between the cold air generating compartment and the refrigerating compartment and configured to guide cold air generated by the evaporator toward the refrigerating compartment;

a first closable damper positioned in the first cold air outlet and configured to control supply of cold air generated by the evaporator through the first cold air outlet to the freezing compartment;

a second closable damper positioned in the second cold air outlet and configured to control cold air generated by the evaporator through the second cold air outlet to the refrigerating compartment;

a first cold air fan located in the first cold air outlet and configured to move cold air generated by the evaporator through the first cold air outlet and into the freezing compartment;

a second cold air fan located in the second cold air outlet and configured to move cold air generated by the evaporator through the second cold air outlet and into the refrigerating compartment;

a first return duct that connects the freezing compartment with the cold air generating compartment and that is configured to guide air from inside of the freezing compartment toward the cold air generating compartment;

a second return duct that connects the refrigerating compartment with the cold air generating compartment and that is configured to guide air from inside of the refrigerating compartment toward the cold air generating compartment;

a first cold air inlet provided in a left side wall of the cold air generating compartment and connected with the first return duct to draw cold air having passed through the freezing compartment;

a second cold air inlet provided in the right side wall of the cold air generating compartment and connected with the second return duct to draw cold air having passed through the refrigerating compartment;

a first return damper positioned in the first cold air inlet and configured to control air flow through the first return duct; and

a second return damper positioned in the second cold air inlet and configured to control air flow through the second return duct,

wherein the first return duct is arranged along a left side wall and a top wall of the freezing compartment and the left side wall of the cold air generating compartment, the left side wall of the freezing compartment defining a left side of the freezing compartment and extending from a rear wall of the freezing compartment to a front of the freezing compartment, and

wherein the second return duct is arranged along a right side wall and a top wall of the refrigerating compartment and the right side wall of the cold air generating compartment, the right side wall of the refrigerating compartment defining a right side of the refrigerating compartment and extending from a rear wall of the refrigerating compartment to a front of the refrigerating compartment.

2. The refrigerator of claim **1**, further comprising a control unit configured to perform operations, the operations comprising:

accessing a first temperature measurement for the refrigerating compartment;

accessing a second temperature measurement for the freezing compartment;

comparing the first temperature measurement to a first temperature threshold;

comparing the second temperature measurement to a second temperature threshold;

determining whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold based on the comparisons; and

controlling the first closable damper and the second closable damper to supply cold air generated by the evaporator to the refrigerating compartment only, the freezing compartment only, or both the refrigerating compartment and the freezing compartment based on the determination of whether the first temperature measurement is above the first temperature threshold and whether the second temperature measurement is above the second temperature threshold.

3. The refrigerator of claim **1**, further comprising:

fan driving members located at the first and second cold air fans; and

damper driving members located at the first and second closable dampers and the first and second return dampers, respectively.

4. The refrigerator of claim **1**, wherein the first and second return ducts are configured to guide air of the storage compartment into the cold air generating compartment to pass through the evaporator from top to bottom.

5. The refrigerator of claim **1**, further comprising:

a water collecting tray provided under the evaporator and inside the cold air generating compartment, the water collecting tray being configured to collect defrost water generated by the evaporator and having a cold air guiding recess provided in the water collecting tray to guide the cold air of the evaporator toward the first and second cold air outlets.

6. The refrigerator of claim **5**:

wherein the first and second cold air fans are positioned directly under the cold air guiding recess and installed in centers of the first and second cold air outlets, respectively.

7. The refrigerator of claim **5**, wherein:

the first closable damper is rotatably mounted between the water collecting tray and the first cold air fan, and

the second closable damper is rotatably mounted between the water collecting tray and the second cold air fan.

8. The refrigerator of claim **1**, further comprising:

a first housing defining the first machine compartment;

a second housing defining the second machine compartment;

a first cover member located on a front of the first housing and having a first plurality of communication holes; and

a second cover member located on a front of the second housing and having a second plurality of communication holes.

9. The refrigerator of claim **1**, wherein the first and second cold air fans are cross-flow fans.

10. The refrigerator of claim **9**, wherein the first and second cold air fans are configured to rotate toward each side of the partition wall to cause cold air to move vertically downward along the partition wall.

11. The refrigerator of claim **10**, wherein the first cold air fan rotates in a clockwise direction and the second cold air fan rotates in a counter-clockwise direction.

12. The refrigerator of claim **1**, wherein:

the cold air generating compartment is an airtight space surrounded by insulation walls, and

the first and second cold air inlets and the first and second cold air outlets pass through the insulation walls and are configured to enable communication between the cold air generating compartment and the freezing and refrigerating compartments.

13. The refrigerator of claim **1**, wherein the cold air generating compartment is located over both of the freezing compartment and the refrigerating compartment and configured to supply cold air from the cold air generating compartment to both the freezing and refrigerating compartments uniformly.

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